NATURAL GAS.

A Monograph.

BY CHARLES PAINE.

Natural gas, or Rock gas, as it is often called, is a fluid or vapor of about one-half the specific gravity of atmospheric air, varying, according to the place of its origin, from .45 to .55, and of course, according to its composition, which is found to differ considerably in adjacent wells, and even at different times in the same well. There have been many determinations of the composition of Pittsburg Natural gas, the average of which, adopted by Mr. S. A. Ford, the chemist of the Edgar Thompson Steel Works, is as follows:

	PER CENT.
Carbonic acid	.6
Carbonic oxide	.6
Oxygen	.8
Olefiant gas	1.
Ethylic hydride	5.
Marsh gas	67.
Hydrogen	22.
Nitrogen	3.
	100.

The Findlay, Ohio, gas, as determined by Prof. C. C. Howard, yields:

	PER CENT.
Marsh gas	92.61
Olefiant gas	.30
Hydrogen	2.18
Nitrogen	3.61
Oxygen	.34
Carbonic acid	.50
Carbonic oxide	.26
Sulphuretted hydrogen	.20
	100.00

The heat units in 100 litres of Pittsburg gas are calculated at 789,694; in Find'ay gas at 878,082; and (for the sake of comparison) in the same quantity of Siemen's producer gas at 113,000; these results being the average of several determinations. Experiments under various boilers have shown 1,000 feet of gas to be equal in heating power to from 80 to 133 pounds of coal. The committee of engineers of the Society of Western Pennsylvania, appointed to investigate the question, concluded that one pound of coal was equal in value to 7½ feet of average Natural gas. It explodes violently when mixed with from nine to fourteen parts of air. The flame temperature of Natural gas, when burned with pure oxygen, is estimated by Mr. F. W. Taylor at 7,100 degrees C., and of the Siemen's producer gas at 2,850 degrees centigrade; when burned with just enough air to insure perfect combination, the temperatures are estimated at 2,333 degrees C. for Natural gas, 1,700 degrees C. for Siemen's.

The Natural gas has generally but little odor; yet is often found strongly scented with the fumes of petroleum or of sulphuretted hydrogen. The absence of odor has usually been considered a defect, as lessening the chances of discovering leaks from the pipes in which it is carried; but the sense of suffocation produced by inhaling air which has been charged with only a very small portion of the gas, would seem to be a warning of its presence quite as palpable as its odor. The gas is described as colorous, yet it may be seen to have a pale blue tint when blown into the air from a well under high pressure, quite like the column of high pressure dry steam from a boiler. This color may be due to the presence of minute quantities of water, or of oil, in suspension; for, as discharged from the wells, there is always some moisture and some oil, which may be separated from the gas by discharging it into a tank on its way to the conducting mains, the precipitated water and oil being drawn off at proper intervals.

The theories of the origin of gas are several; and it is not worth while to discuss them here at much length, because none of them accounts for all the facts; and, at present, the theories have not much practical bearing. The probabilities are that petroleum and gas are derived from the same sources; they are always found in conjunction. They appear to have been produced from organic matter, to have escaped from the region in which they were produced, and to have been entrapped in certain open or porous rocks, where they have remained imprisoned until discovered by the drill, or by their issuing through crevices in the rocks, leading to the surface.

It is probable that gas may be found in any of the strata which have been deposited since the Archæan rocks. In Northwestern Ohio the gas is found in the Trenton limestone, which is in the second series of strata above the Archæan rocks; and more or less gas has been found in each of the subsequent strata up to the coal measures; indeed, it exists even in the glacial drift.

Starting at the oil region in Upper Canada, passing through Black Rock to the southwest corner of Pennsylvania, the sedimentary rocks dip gently and somewhat uniformly to the southwest, the lower rocks outcropping at the northeastern end of the section, while the full series, extending to the upper barren coal measures, are found at the southwestern end. It is remarkable that upon this line, the oil or gas, in profitable quantity, is found only in those strata of sandstone which happen to be at a depth of from 500 to 2,000 feet below the surface; and that deeper drilling in any place along this line has not succeeded in finding a stratum which was, at that place, productive of either oil or gas in valuable quantity, although yielding both in abundance at some other locality, where it is nearer the surface.

In Canada, the oil is found in the Corriferous lime, stone. As we go southwestward, the Bradford sand- the next group above, is the productive stratum; still further south, the Warren oil group, which lies above the Bradford; further southward, and above the Warren, the Venango group of sands, and still further to the southwest, the Conglomerate measures yield the gas and oil. In Northeastern Ohio, in the vicinity of Mecca, the oil is found at small depths, less than 100 feet, in the Berea grit, immediately under the bowlder clay; but its gas, and almost all the volatile products usually contained in the petroleum, have been evaporated; in consequence of which the oil attains the gravity of from 26 to 28 degrees "B," which made it the valuable lubricating substance for which there was a wide demand, so long as its production continued. The gas and oil in Northwestern Ohio, found in the Trenton, lie about 1,100 feet below the surface.

The reservoirs of gas and of oil seem to vary in dimensions from the smallest pocket up to thirty or forty square miles in extent, and 100 feet or more in thickness. It is important to the finding of the gas that the rocks shall not have been violently disturbed and broken, because the gas certainly would have escaped through the openings produced by the fracture of the rocks; so that it would appear idle to search for it in the immediate proximity of mountain chains; but it may be looked for in almost any quarter, wherever the strata have not been violently disturbed, between the Upper Carboniferous and the Archæan. In Southwestern Pennsylvania these strata are very closely conformable and of remarkable uniformity in thickness; but in no other part of this country is it possible, without very careful investigation to determine at what depth a specified stratum will be found. The several contiguous strata may contain water, oil and gas in intimate mixture, or they may be separated by short intervals one from the other. The natural expectation that the gas would be found at the top, then the oil, then the water, is frequently reversed; and in some places we first pass through a stratum of salt-water, then a stratum yielding oil, and finally reach the gas in a lower stratum. It is manifest that there is no communication between the strata, where this condition of things exists. When first reached, the tension of the gas is commonly very high. The highest measured pressure of which we have knowledge is 750 pounds to the square inch; but, from various phenomena exhibited, and the judgment of well-diggers, familiar with these astonishing pressures, we may conclude that a thousand pounds per square inch is not very unusual at the first penetration of the drill into the reservoir. It is not at all uncommon for the drill, and the rope, and even the casing, to be blown out of the hole, from a depth of 1,500 feet, over the top of the derrick, like an arrow from a bow-gun. In any given pool, as it is called in the oil country, there seems to be a sufficient porosity of the rock, in which the deposit is contained, to admit of an approximate equalization of pressures among the several wells, so that throughout an area, of one or two miles square, the wells, if shut in, will have substantially the same pressure, not varying among themselves more than 30 or 40 pounds per square inch.

For the last few years, much credit has been attached to the anticlinal theory, in the searches for oil and gas. The drillers, in Western Pennsylvania, have faith in an angle of 45 degrees from the meridian, northeast and southwest; so that a successful well having been obtained, they immediately start the drills upon a line protracted upon the northeastern and southwestern courses from it. It happens that in Western Pennsylvania the folds in the strata, which form the anticlinals and synclinals, are approximately parallel with the crest of the Allegheny Mountains, which run rudely to the southwest from the northern boundry of the State, although with a very decided bend, which is followed by the foldings, and also by the remarkable parallelism of the oil territory, so far as it has been exploited. Of course, the real position of the anticlinal fold can only be determined by careful geological explorations on the spot. Prof. I. C. White, the champion of the anticlinal theory, has had remarkable success in the location of the wells which have been sunk under his direction; nevertheless, there are excellent gas and oil producers, which lie exactly in a synclinal trough. It, therefore, appears of more consequence to find a reservoir which has received and retained the gas, than that it should be situated either at the top or bottom of a fold in the strata. Of course, upon the exhaustion of the reservoir, the last few pounds or ounces of pressure would be obtained from the summit of the reservoir; but only the drill can tell whether the reservoir extends to the top of the fold, or lies entirely in the bottom of the synclinal. The reservoirs in the sandstones were formed before the folding of the strata. The denser strata of sandstones or shales surrounding the porous masses, containing the gas, do not seem to be permeated by it in any sensible degree. Those who wish for more particulars on this point, are referred to the interesting discussions by Professors Leslie, Ashburner, Carll and White. At the last meeting of Mining Engineers at St. Louis, Mr. Ashburner read an especially instructive paper upon the geologic distribution of natural gas in the United States; which will be found among the proceedings of that society. In it, he thoroughly explains how mystified and misled any but an expert geologist must be, in an endeavor to calculate the depth at which certain strata will, at any point not contiguous to previous drillings, be reached; yet such an expert geologist can advise, after sufficient examination, with reasonable certainty as to the depth at which strata, capable of bearing oil or gas, may be found. Of course, only the drill can tell whether either is there in abundant quantities, or not; even a distance of a few rods or a few feet, may separate a very productive well from a non-productive.

The method of drilling for gas is precisely similar to that employed in drilling for oil, which has been reduced to such a trade and organized business, that one may order from one establishment every article necessary for an outfit. Ordering a "carpenter's rig" from the men who make a business of furnishing such, they will ship to the point desired, for the sum of about $200, every piece of timber or lumber which is required for the erection of a standard derrick, with all its attachments; another firm supplies the rig irons for about $60. The rig-builder, for the sum of about $100, will put these parts together; set up in complete readiness for the operations of the driller. The driller furnishes the engine, rope, tools; and drills the hole required (if inside of 2,000 feet deep) at a price varying, with the territory, the hardness of the rock, and the distance from the base of supplies, from $1 to $2 per foot in depth. If water is encountered, it must be cased off by inserting a tube called the *casing*. The standard well-casing is 5¾ inches interior diameter, which will go easily into the standard 8-inch hole; the hole below this casing is 5¼ inches in diameter. A complete description of the processes of well-sinking, showing the tools used, etc., will be found in Prof. Carll's "Report on the Oil Wells of Pennsylvania," Vol. III, of the Pennsylvania Geological Survey.

One of the most remarkable features of well-sinking is the indifference of the drillers to the loss of their tools. It would seem as if they regard it as a pleasant feature of the business to have a "fishing-job" on hand as they term it; when they have, by their carelessness, allowed their tools to fall in a hole something over 1,000 feet deep, because of the rope or the derrick-head, or something else wearing out and breaking. The next most surprising thing is the ingenuity of the contrivances which have been devised to recover from this seemingly hopeless calamity. In the majority of instances they do manage to pick up the tools and to continue the well. The whole apparatus for well-sinking is of the most rude and simple description of anything known to mechanics; yet so admirably adapted to its work that it would be difficult to improve upon it in any respect, except as to its appearance.

It seems to be well determined that the gas in any reservoir is a limited quantity and not an infinite one, as has been supposed. No doubt the laboratory of Nature is at work producing the gas, perhaps in very large quantities at the present time, as heretofore; but we do not know certainly that the process of gas production is taking place in the vicinity of the reservoirs which we have discovered. A great many of the small reservoirs have been nearly or quite exhausted, although many of them continued to supply the limited demand which was made on them during many years; and it seems probable that as the oil pools have been exhausted of the larger portion of their contents, so we may expect to finally exhaust the largest gas-pool which has yet been reached. Fortunately, the great thickness of the strata, and the frequency of the occurrence of porous masses in them, suitable for the storage of gas, seems to promise a long-continued supply in those regions, such as Western Pennsylvania and Ohio, where the strata have been but little disturbed. Mr. Peter Neff, of Cambia, Knox County, Ohio, asserts that his *Well No. 2* has been systematically examined during the last fourteen years, and there has been no apparent diminution in the supply during that time, and that the well has been *blowing* during twenty years. Instances of this kind are not infrequent, and have given rise to the theory, supported by Mr. Lorin Blodgett and others, that the hydro-carbons are being distilled now, in vast quantities, at the proper depth below the level of the ocean, and are constantly re-

supplying these natural reservoirs through the same avenues by which they have heretofore been filled.

It may be remarked, in passing, that we are beginning to approach the economy of nature in the production of fuel gas: and were the supplies, which are supposed to have been derived from the shales and stored for use in the sandrocks above them, to be completely exhausted, we would be able to substitute thereof a gaseous fluid, for a price quite within the purchasing power of manufacturers.

The search for natural gas, and its exploitation, is being conducted with wonderful vigor. In Western Pennsylvania alone there are incorporated fifty-two Natural-gas companies; perhaps others, the names of which have not been noted. The other Western States are following suit, and there seems to be great promise that Kentucky, Ohio, Indiana, Illinois and Missouri, and perhaps Wisconsin, will be supplied from the Natural-gas reservoirs. The Department of the Interior, of the United States Government, reports the total value of the Natural-gas produced during the calendar years mentioned, as follows:—

1882	$ 215,000.00
1883	475,000.00
1884	1,460,000.00
1885	4,854,200.00

The usual products of Natural-gas besides heat and light are a superior lamp-black, called diamond-black; and, when improperly burned in furnaces, two forms of nearly incombustible carbon; one resembling in appearance Cannel coal, the other more nearly resembling in appearance a very dense coke, from which superior pencils are made for the electric arc light. The illuminating power of the gas is low, reckoned at eight candles upon the usual scale. There are many systems by which it is enriched with carbon, in order to improve it as an illuminant, chiefly by the use of the lighter products of petroleum; the mixture being converted into a fixed gas by the use of heat and of superheated steam; but the heat evolved in burning it renders the Natural gas unfit for illuminating any but large or open spaces. It is better to use the gas to produce the electric light through a dynamo. The torches of Natural gas make a very good light for yards, rolling mills and streets. The gas has not yet been successfully used in smelting iron-ore; with this exception, it may be used for all purposes for which heat is required and is superior for those purposes to any other fuel yet known. It is so perfectly subject to control as to quantity consumed, as to distribution in the furnace, or kiln or oven, and is so perfectly free from sulphur or other objectionable admixtures, that it is held by all classes of manufacturers to be beyond comparison the best and most convenient fuel. For the heating of dwellings and for cooking, it is convenient, controllable, cleanly and most comfortable: it soils nothing; there is no dust attends upon it; it may be lighted in an instant, burns equally for as long as wanted, may be increased or diminished in intensity at will, and may be extinguished in an instant; it is always at hand and requires no attention from the consumer to procure a supply after the pipes are laid. It is supplied almost everywhere, where there are organized companies, at a less price than its equivalent in coal.

The engineering problems connected with the search for gas were nearly all solved during the search for oil; and the dangerous physical characteristics of the gas had come to be thoroughly well understood from experience, by explosions and burnings at the oil wells. Some efforts were early made toward the utilization of the gas, as at Fredonia, N. Y., in 1821, and it was piped in small quantities for the lighting of villages, heating of houses, the burning of brick, the manufacture of lamp-black, etc., upon a small scale. For many years before the piping of high pressure gas, for the supply of furnaces, rolling mills, etc., was undertaken, it had been known to gas engineers, and to steam engineers also, that the most difficult part of their operations in conveying these fluids from the place of manufacture to the place of use, was to secure the joints of the pipes from leaking. Two reports of gas engineers made within the past year or two, indicate that there is still a loss of from fifteen to thirty per cent. of the total production of gas in cities, due to leakage. Mr. Charles E. Emery, in his admirable lecture before the students of Cornell University, gives a similar account of the losses experienced in the transportation of steam.

Railroad and Engineering Journal.

(TO BE CONTINUED).

A NEW process for making steel pipes is now employed at Burbach. A syndicate has been formed to build works, the capital being 1,200,000 marks, of which 600,000 marks are issued to the patentee, A. Mannesmann, of Remscheid. It is proposed to apply the method to the manufacture of copper tubing. The process is as follows:—As soon as the steel is cast into the round mould a core is thrust into the steel, so that a tube is formed between it and the walls of the mould. In order to prevent cracking of this annular casting during cooling, the core is so made that it follows up the shrinkage of the steel. The steel cup thus obtained may then be rolled in an ordinary train.

Municipal Engineering; Paper No. 4.*

PHILADELPHIA, PA.

(*Continued from page 54.*)

Vaults Under Streets.—Licenses, costing $1 per foot front, must be obtained from the Highway Department for vaults under sidewalks, the center of all openings to which shall be at a distance of not over 2 feet from the line of the curbstone,† "and all openings must be covered by an iron plate or grate made of iron bars of at least 1 inch square in thickness,† or of any other substantial material which may be authorized by the commissioner of highways, fixed in a frame of iron or stone." Fire hydrant connections passing through vaults must be enclosed "in such a manner as to give them a sufficient support and protect them from freezing." Coal is seldom put into the cellars of dwellings in Philadelphia through holes in the sidewalks, but is run over the sidewalk into cellar windows through telescope chutes from tilting wagons.

Public Lamps.—The public lighting of the city is chiefly by the common gas lamps of which there are in use about 16,000. With one exception all the gas works are owned by the city and are managed by a board of twelve trustees elected by councils. The location of street lamps is decided directly by Councils. No rule is observed, but there is generally one at each street intersection, just inside the curbstone and on the corner when that is not occupied by a sewer inlet. On long blocks sometimes two or three are placed between streets. Matches are used exclusively in lamp lighting —one man to sixty-five lamps. The lamps are used twelve hours a day, on the average.

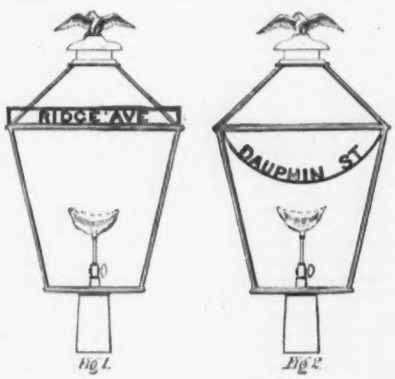

Plate. 12.—Street Signs.

In the rural districts where gas pipe has not been laid, gasoline is used—in all about 4,000 lamps of the Maloney Company patent. The city pays (a company) $21 a year for furnishing naphtha to and lighting, extinguishing, cleaning and repairing each lamp. Where the sidewalks or pavements are good the lamp lighters sometimes have small hand-carts in which to transport the naphtha cans and cleaning and repairing tools, but in the greater portion of the area thus lighted, they carry the same by hand. Some of the districts are so large that in the shorter days they begin lighting about the middle of the afternoon.

Regenerative gas lamps are in use in several of the public parks.

Three hundred and fifty-two electric arc lamps (rated at 2,000 candle power) are now (September, 1886), in use, costing the city about 55 cents a piece per night.

Street Signs.—Throughout a large portion of the city the names of streets are shown on corner lamps by Marshland's patent—a thin plate of iron about 2 inches wide—with the letters cast in it, placed on each face of the lantern and fastened together at the ends (Fig. 1, Plate 12.) More recently they have been shown as represented in Fig. 2 Plate 12, letters cut from sheet tin and soldered to a brass wire sprung between the opposite faces of the lantern in a curve. They are also largely indicated on strips of wood nailed to the corner buildings—formerly by black letters on a pale yellow, more recently by white letters on blue. At, many street corners, especially in the rural portions, no signs appear. This work is at present done by the Police Department, or under contracts made by them.

Street Railways

Horse car tracks appear in almost every street in the built-up portion of the city and they extend in all directions far into the suburban districts. According to the accompanying extract and summary of the report to the State Auditor General for the year 1884, the total number of miles of road in the city is nearly 429. At least one road (Roxborough and Barren Hill) appears to be omitted. Counting this, and new extensions built since 1884, the total mileage will probably be near 450. With the exception of about nine miles of cable road now in operation, and a short branch in Frankford on which steam is used, horses (and a few mules) furnish the motive power.

Generally only one track is placed in a street. (In some cases this is used by several lines, but as a rule each line has independent tracks.) Where two tracks are laid in the same street they are at least three feet apart. The gauge is about 5 feet 2 inches (on some roads it is 5 feet 2½ inches and on others 5 feet 2½ inches but any truck will run on all city tracks). Only one type of rail is used in the city. (See Plate 13). It was designed as a tram rail for carts and wagons as well as for passenger cars, having a wide base (5 inches), and with the inner half an inch lower than the head on which the car wheels run; on one line (Chestnut street)

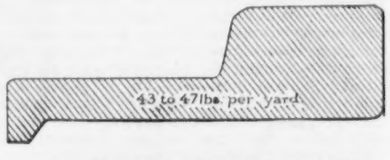

Plate. 13.—Philadelphia Rail; Half-Size.

this inner part is extended to a width of 4½ inches. The Philadelphia rail (steel) weighs about 45 pounds to the yard (43 to 47 pounds) and is 30 feet long. It is supported on longitudinal stringers, usually of yellow pine, 5 inches by 7 inches and from 30 to 50 feet long, to which the rails are spiked every two feet or less. The stringers rest on wooden crossties, 4 inches by 6 inches 7 feet in length and 4 feet apart. The stringers are joined by ½ inch iron plates, 15 inches long, turned down over the edge of the stringer on each side and cut into the wood to the depth of the plate. Cross ties under stringer splices are secured to the latter by knees of angle iron.

The horse track between the rails is paved generally (on cobble paved streets) with small selected cobble stones rather smaller than shown in Plate 14, which illustrates the construction. The horses wear peculiar shoes designed to fit the stones and secure a firm hold

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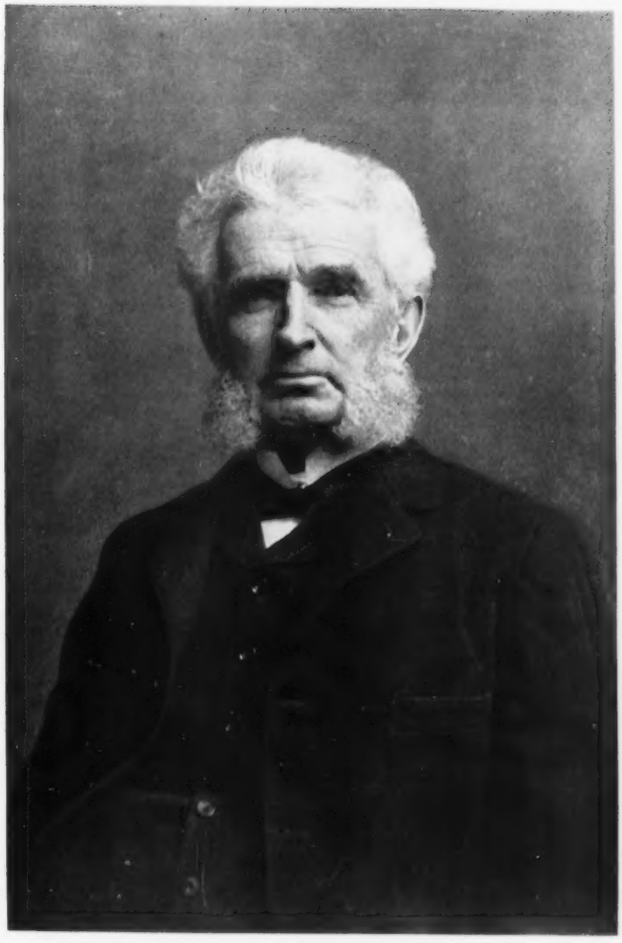
† Commonly violated.



A. E. Barstow

Name of Company.	Capital Stock.	Total Cost of Road and Equipment.	Miles of Road.	No. of Passenger Cars.	No. of Horses.	No. of Passengers Carried.
Citizens'	$500,000	$319,134.57	10.50	92	426	6,069,498
Empire	600,000	.....	8.50	.....	.....	†
Frankford and Southwark	750,000	982,175.45	18.10	99	580	9,813,910
Germantown	1,500,000	.....	.....	.....	.....	††
Green and Coates streets	500,000	.....	.....	.....	.....	††
Hestonville, Mantua and Fairmount	2,050,000	537,994.56	20.00	75	466	4,776,091
Lehigh avenue	600,000	.....	.....	.....	.....	§
Lombard and South streets	750,000	658,566.64	17.76	51	278	3,640,730
Peoples'	1,500,000	289,547.35	44.00	174	1040	20,797,786
Philadelphia City	1,000,000	875,842.88	17.42	.....	.....	‖
Philadelphia and Darby	200,000	.....	5.05	.....	.....	‖
Philadelphia and Gray's Ferry	1,000,000	276,776.53	10.38	28	200	2,968,813
Philadelphia Traction	5,000,000	.....	109.00	595	3160	30,895,139
Ridge avenue	750,000	569,413.24	15.00	61	347	6,283,481
Schuylkill river	500,000	47,463.54	3.11	.....	.....	¶
Second and Third streets	1,000,000	931,178.77	37.00	116	675	9,424,798
Seventeenth and Nineteenth streets	500,000	299,246.60	7.50	.....	.....	**
Thirteenth and Fifteenth streets	1,000,000	321,566.86	14.00	57	447	5,981,089
Union	1,000,000	2,491,250.68*	70.00	.....	.....	11,743,313
West Philadelphia	750,000	1,141,871.55	21.50	.....	.....	**
Totals	21,510,000	9,742,029.22	428.82			112,394,648

*Includes real estate.
†Leased to Citizens' and Seventeenth and Nineteenth streets.
††Leased to Peoples'.
§Branch of Frankford and Southwark.
‖Operated by West Philadelphia.
¶Operated by Philadelphia and Gray's Ferry.
**Included in Traction.

The track is generally drained at the lowest points of grade, through openings under the rail, the stringer being cut down; but at many of the most important places (perhaps a hundred in the whole city) sewer inlets are placed between the rails, a rectangular iron grating over a funnel shaped basin connecting

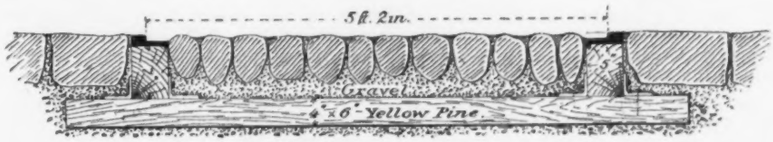


Plate.14.—Philadelphia Street Railway.

at the bottom directly into the top of the sewer (without a trap). This is done by the Survey Department.

The construction of the cable car tracks and conduits is shown in Plate 15. The diagonal tie rods to hold the slot open were at first omitted, but were found necessary after the first winter. The slot is from ⅛ to 1 inch wide. Twenty-two miles are proposed by the

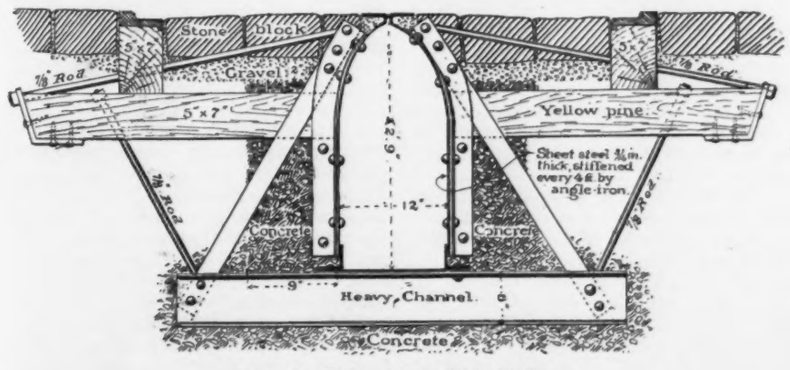


Plate. 15—Philadelphia Cable Railway.

traction company and sixteen miles are laid, but only nine are in operation. Cable cars were first run regularly in 1885 and the system is not perfected to the company's satisfaction, though cars have been running regularly on Market Street for several months. For several months after first starting, there were frequent failures and horses had to be sent out to haul the cars. It was found that the common truck was unsuited to the short curves and a new and peculiar form is now being experimented with. The wire rope cable is fifteen-sixteenth-inch in diameter and the longest one in use is 21,000 feet.

The public in general seem satisfied and pleased with the cable road. At first there was an outcry by the doctors that the conduit would be an open sewer or worse and it is true that the conduit laid more than a year ago and not yet in use has become more or less filled with street detritus which cannot but be unsanitary, but that in use seems to be kept well cleaned by regular men with special tools. At the lowest points of grade it has trapped connections with the sewer.

As previously stated ordinances require passenger railway companies to keep in repair and improve the pavements of streets occupied by them, but this has been practically a dead letter, so far as any improvement is concerned. The running speed is limited by ordinance to six miles an hour in the built up portion of the city. A license of $50 for each car used is required annually to be paid to the Highway Department. Companies are required to keep their tracks free of snow, but are not allowed to use salt for that purpose, except on a few defined streets on the outlying parts.

(TO BE CONTINUED).

Metallic Railway Track.

Translated for ENGINEERING NEWS.

BY E. E. RUSSELL TRATMAN.

This paper is a translation and adaptation of a very complete and interesting article by M. Simon Cantagrel, published in the *Memoires de la Société des Ingénieurs Civils*, Paris; July, 1886.

The International Railroad Congress held at Brussels in August, 1885, investigated the subject of metal tracks for railroads and reported as follows "Tracks with metal cross ties, considered from a technical point of view, can compete with tracks laid with wooden cross ties, as well for lines having a heavy traffic as for those with a lighter traffic. From a financial point of view, this competition is still possible, but in every case, in order to make a comparison between the two types of track, the price of the materials, the cost of maintenance and the probable durability of these materials must be taken into account. The result of the comparison will show what type of track should be preferred."

The author has endeavored to establish a base of comparison, not only between tracks on wooden and metal cross ties, but also between the various types of tracks composed entirely of metal. The article is a compilation; it is as complete a resumé as possible of the various types of metal longitudinals and cross ties that have been put into practical use; but it does not deal with those which have not been actually tried, nor with those which have not, from the beginning, given satisfactory results. For the purpose of compiling the article the follow publications have been consulted: *Bulletins de la Société des Ingénieurs Civils; Revue Gènèrale des Chemins de Fer*; *Le Genie Civil*; *Société Belge des Ingénieurs et Industriels; Iron Permanent Way*, by Mr. C. Wood, M. I. C. E., *Iron and Steel Permanent Way*, by Mr. Walter R. Browne, M. I. C. E., *Steel Permanent Way*, by Mr. Francis W. Webb, M. I. C. E., and the official report on metal tracks in foreign countries, made under orders from the Minister of Public Works, by M. Bricka, chief engineer of the French State Railroads.

Longitudinals.

Barlow. (Fig. 1).—The first attempt at a track

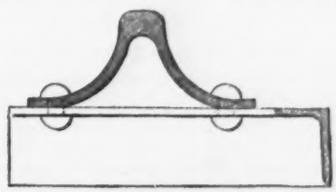


Fig. 1.—Barlow.

composed entirely of metal was made by Mr. Barlow, whose rail was the first longitudinal invented. It was first brought out in 1849*.

Macdonnel. (Fig. 2).—The Barlow "self-con-

*M. Cantagrel illustrates this with a section showing the rail riveted to a tranverse angle iron; unless this is meant to represent a joint (though my impression is that the joints were not made in this way) it is difficult to see the appropriateness of the illustration, as Barlow's idea was to do away with everything but the rail. Mr. John Wolfe Barry, M. I. C. E., in his "Railway Appliances," says "The rail was intended to dispense with sleepers and chairs altogether. The rail is laid directly on the ballast, and the ballast is in ended to completely fill the inside of the saddle back. The bearing area on the ballast can no doubt be made ample enough to support the loads coming on the line, but the rail, unless its two sides be held fast, is vertically weak: while unless the ballast be kept absolutely tightly packed into the rail, the wings of the rail spread elastically, and, working in and out, gradually displace the ballast beneath them. The saddle-back rail has been largely used at home and abroad and was thought at one time likely to form a very desirable and efficient description of road, composed of lasting materials with a minimum number of parts and fastenings, but experience has shown that so far at least as it has up to this time been used, it leaves much to be desired, and that it is not well fitted for high speeds or for heavy traffic."—TRANSLATOR'S NOTE.

tained" rail, however, presented this inconvenience, that the wear of the head entailed the replacing of the entire rail. Mr. Macdonnel in 1853, first conceived the idea of separating the longitudinal from the rail proper and put down on the Bristol & Exeter R. R. (England) the track that bears his name. It consists of a continuous base plate on which is placed the rail, with an intermediate bearing-piece of wood to give a more elastic track; bolts passing through the base of the rail, the wooden bearing piece

Fig 2.—Macdonnel.

and the longitudinal, hold the parts together. This form of track has done good service for a long time and is still in use. For thirty-three years it has been in use, and the engineers of maintenance of way found it in good order in 1881. This is the longest continuous experience with metal track that can be cited. This track, in good order in 1881, under conditions of speed and traffic unknown in 1853, should certainly have been carried to perfection. However, this long experience has enabled exact account to be taken of the inherent merits of the various systems of metal track; merits which will be referred to in detail and which may be summed up thus: economy in cost for maintenance of way; economy of ballast; a more easy riding road and, in consequence, economy in maintenance of rolling stock. Mr. Charles Wood, M. I. C. E., in a paper to the Institution of Civil Engineers (England) gives the following notes on the expense: the track on wooden cross ties required in 1861 an expenditure for new lines of $7,677.85 per mile; at the same time the estimated cost for the Macdonnel track was $5,262.25 per mile and Mr. Wood, taking the price of materials in 1881, estimated a probable cost at that time of $4,300.56 per mile.

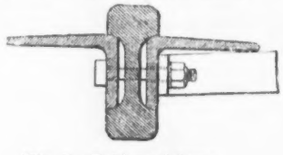


Fig. 3.—Bridges Adams.

Bridges Adams. (Fig. 3).—This plan was invented in 1853 by Mr. W. Bridges Adams and consisted of continuous angle irons bolted to the rail. It did not give satisfactory results.

Hartwich.—In 1865 the Hartwich type was experimented with on the Rhenish railroads of Prussia. In principle it consists of a Vignoles (T) rail of large section. The proper distance is maintained between the two lines of rails by gauge rods which are attached to the web of the rail by bolts; the web is strengthened at the points of attachment by wedge-shaped plates which allow of the required cant being given to the rail; strong angle splice-bars secure the joints. The type met with much favor and in 1870 there were 111.6 miles of track, but it has been partly abandoned and in 1880 there were only 10 miles on main lines and 31 miles on secondary lines. Now, however, the directors of the railroads of Alsace-Lorraine and Bavaria intend to institute further experiments.

In Alsace-Lorraine (Fig. 4) the rail is 7.2 inches in height, with a flange 4.8 inches in width; the splice bars are 10 inches long and are fastened by two rows of bolts; the gauge rods are of 1.04-inch round iron and are spaced at intervals of 9.84 feet. The joints are placed between two rods placed closer together.

In Bavaria (Fig. 5) the rail is 6 inches high with a flange 4.8 inches in width. The splice bars are 10 inches long and are fastened by two rows of bolts; the joints are strengthened by a chair placed under the rail, of the same length as the splices and fastened to the rail flanges by bolts. The gauge is maintained by flat iron bars spaced 2.29 feet at the joints and 9.08 feet elsewhere. The rail weighs 58.5 pounds per yard and is 29.5 feet long; the track complete weighs 136.11 pounds per yard.

The dimensions given are very large but the difficulties of rolling will not permit a flange to be made wide enough to give the track a satisfactory bearing on the ballast. In fact it is admitted, and railroad engineers well know, that a proper ballasting cannot be made with width of less than from .65 to .72-foot.

Daelen. (Fig. 6).—In 1866 M. Scheffler invented for the Brunswick R. R. a longitudinal system composed of three parts, the main feature being a rail consisting of a head only. M. Daelen modified the Scheffler type to a slight extent in 1867 and obtained a sufficiently strong longitudinal, but the high cost of manufacture, the constant attention to the tightening up of the bolts and the difficulty experienced in employing these longitudinals on curves, because it was absolutely necessary to bend the several pieces while hot, are sufficient reasons to explain the very small success attained by this system.

Hilf. (Figs. 7, 8).—In 1867, M. Hilf first put in service a longitudinal entirely independent of the rail. This type is the one most extensively used in Germany, either the original form or types derived therefrom. The original type had the form, in section, of a reversed E (m), the central rib being to strengthen the upper table under the rail, but it was soon evident that this rib prevented the regular tamping of the ballast under the tie; the ordinary form of rail was also adopted in place of those weighing 52.5 pounds per yard which were used in the first experiments made on the line from Ems to Wiesbaden. On the Alsace-Lorraine lines the rails are .39-foot in height and weigh 56.4 pounds per yard; the longitudinals are 24.6 feet in length, weigh 59 pounds per yard and have a cross-section 12 inches in width by 2.4 inches in height. As above mentioned they have no longer a central rib. The rail joints are secured by strong angle splice-bars .6-inch in thickness; the joints of the longitudinals are not spliced, being maintained by the continuity of the rail. The rails are attached by means of bolts and clamps. The gauge is maintained by strong angle-irons, 7.5 feet long, weighing 26.2 pounds per yard, and fastened to the flange of the rails at the interval between two longitudinals; gauge rods are also used, and consist of round bars bolted to the web of the rail and speed at 12.3 feet centers.

Rhenish. (Fig. 9).—The inconveniences of the Hilf type led the engineers of the Rhenish railroads (now belonging to the German railroad system) to devise a new type, known as the Rhenish. It consists of an inverted trough, the edges of the inclined sides being thickened to form a rib. The longitudinals are 24.6 feet long, .98 and .65-foot wide at bottom and top respectively, and .29-foot high; they weigh 72.6 pounds per yard. The rails weigh 60.5 pounds per yard and the joints are made in the same way as in the Hilf type. The longitudinals are connected by strong plates of trough section placed in the interior and fixed to the longitudinals by the bolts which fasten the flange of the rail; these splice-plates are 2.3 feet in length. The gauge is preserved by round iron gauge-rods.

Hohenegger. (Figs. 10, 11).—In 1876 the Northwestern R. R., of Austria, made experiments with a track invented by M. Hohenegger, which was, like the preceding, a modification of the Hilf type. It is 29.4 feet long, .55-foot wide at top and .98-foot at the bottom; it is .24-foot high and weighs 58.8 pounds per yard. The rails weigh 60 pounds per yard; they are attached to the tie by bolts and clamps which grip the flange and are held in place by a rib on the upper table. The rail joints are secured by heavy splice-bars, an angle bar on the outside and one of ordinary form inside. The joints of the longitudinals are made by plates which conform to the interior form of the tie; these plates are 1.37 feet in length and are secured to a transverse angle-iron which serves to maintain the gauge, and to the longitudinal by the bolts which secure the rail: gauge rods are also used. The joints of the rails and ties coincide.

Heusinger von Waldegg. (Fig. 12).—This system, tried in Germany, was peculiar in the elimination of all bolts; the rails were of bridge section and were secured by wedge-shaped keys driven between the jaws placed on the upper table of the tie. The joints of the longitudinals are secured by flat plates bolted to the flanges.

Haarmann. (Fig. 13).—The system of longitudinals invented by M. Haarmann is in use on the railroads on the right bank of the Rhine. The tie is 12 inches wide, and weighs 47.4 pounds per yard. On the raised part, or hood, in the middle, is a shallow groove in which the flange of the rail lies; two cramps, passing through openings in the tie, bear at one end on the inside of the lower flange of tie, and at the other end on the flange of the rail. A bolt passing through the cramps causes them to grip tight and hold the rail in place.

The most recent form of longitudinal (Fig. 14) is the invention of M. Haarmann and is a happy adaptation of the Hartwich type. The combined longitudinal and rail is composed of two similar parts, one of which has a rib and the other a groove in order to ensure accuracy in putting together. Each part represents the half of a Vignoles (T) rail .65-foot in height and with a flange .98-foot wide; the track weighs about 175 pounds per yard. The joints of the two parts of each rail are alternated and are strengthened by splice plates; iron bars placed in an upright position form transverse ties. This new type is of very recent date and has been for a short time in use on a few miles only.

Serres and Battig. (Figs. 15, 16).—This system of longitudinals is on the principle of the Scheffler-Daelen type already described. It dates from 1877 and was laid down on the Austrian State Railroads, and still remains on some of the less important lines. The objects of the inventors were to separate that part of the rail which carries the load —the head—from that part which is merely a support, thereby reducing it to a minimum weight, to obtain the continuity of the rail while leaving room for expansion, to design a form of track which passing loads would tighten and consolidate instead of tending to loosen the parts, and to do away with the small fastenings, etc., which after a certain time are a cause of the disarrangement of the track. The longitudinals are composed of two beams, which present, when placed together, the form of a Λ, and between the jaws of these beams lies the web of the rail, 2.28 inches deep; the head is supported by the flanged tops of the beams. The three pieces are held together by heavy transverse chairs in openings in the beams. To lay the rail, one of the beams is drawn back, and the beams take a firm hold of the rail as soon as they are

put together again. The greater the weight that comes upon the head of the rail the more firmly is the web gripped between the jaws; the arrangement is still further secured by means of a bolt. The beams break joint with each other and with the rails, and the joints are secured by plates bolted to the under side of the lower horizontal flanges. The gauge is maintained by tie bars formed by prolonging the transverse chairs.*

Miscellaneous.—A very complicated and expensive system, invented by M. Kirsch, has been tried on the Grand Central R. R. of Belgium.

A system invented by Dr. Winkler has been tried on the railroads on the right bank of the Rhine; it is similar to the Hartwich type; its essential difference being that the head of the rail is removable, and can be replaced without interfering with the support, or tie.

Remarks.—Theoretically, track carried on longitudinals should be preferable in every way to track carried on cross ties, for these reasons: the rail having a continuous support all shocks are eliminated and there should consequently be an economy in the cost of maintenance of track and a diminution in the wear of the rolling stock; the adoption of longitudinals ought also to give an economy in first cost from the fact that the length of longitudinals for one yard of track is about two yards, while with cross ties it is difficult to reduce the length below two and a half yards; to this important question of economy should be added that the weight per yard of a rail having a continuous support may be safely diminished; finally the moment of inertia of the rail and longitudinal jointly is greater than that of the rail, even when strengthened with regard to its vertical or horizontal axis. All these advantages are more apparent than real, experience has enabled them to be judged upon and has brought out numerous drawbacks which had not been foreseen. The estimated economy in first cost is found to be considerably reduced by the necessity of employing gauge rods strong enough to tie the track firmly together and to give the rail the desired cant. In spite of the strength of the transverse bars employed, it is very difficult to ensure perfect accuracy in the track by these means. In the Hilf system it was attempted to obviate this drawback by introducing cross ties of the same section as the longitudinal under the joints of the rails and longitudinals, but then the joints were found to be too rigid with regard to the general elasticity of the track, which sagged between the joints, occasioning at the middle of the span deflexions of .36-inch to .48-inch during the passage of trains. To reduce the rigidity of the joints these cross ties were replaced by others of T or L iron; the distortions of level were thereby reduced but the economical advantage of longitudinals disappeared. The rail is not really supported for its entire length owing to the uneven ballasting under the longitudinal; this condition not being absolutely fulfilled, it would soon be necessary to return to the use of heavy rails.

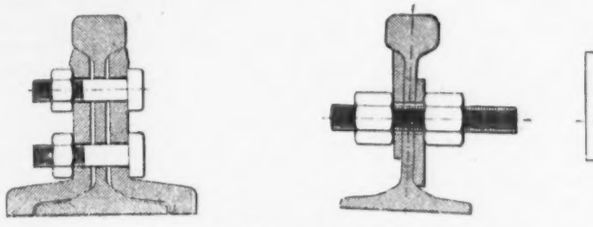


Fig. 4.—Hartwich: (Alsace-Lorraine.)

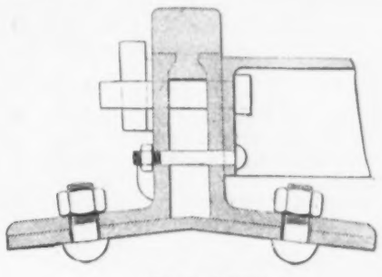


Fig. 6.—Daelen.

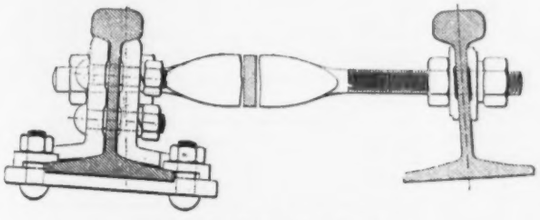


Fig. 5.—Hartwich: (Bavaria.)

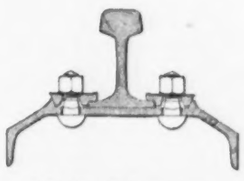


Fig. 11.—Hohenegger.

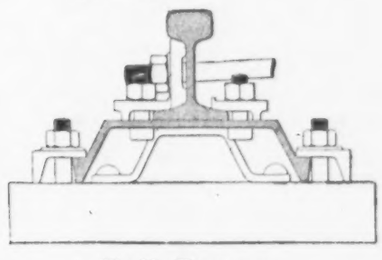


Fig. 10.—Hogenegger.

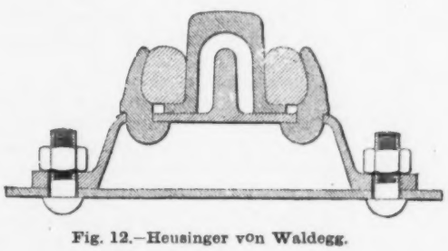
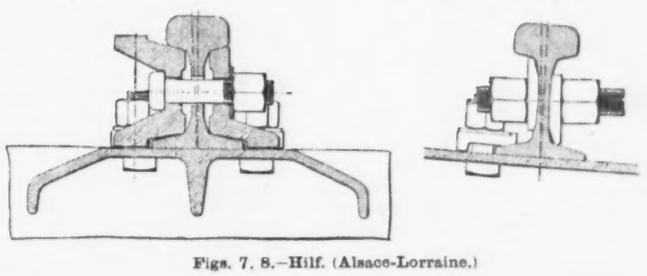
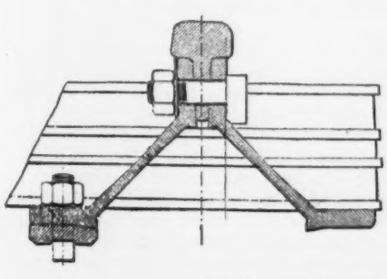
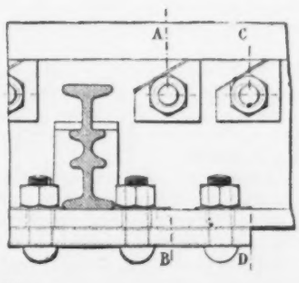


Fig. 12.—Heusinger von Waldegg.



Figs. 7, 8.—Hilf. (Alsace-Lorraine.)





Figs. 15, 16.—Serres and Battig.

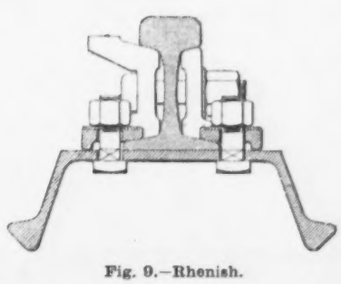


Fig. 9.—Rhenish.

	Ordinary Track.	Serres and Battig. Metal Track.
Rails	$3.36	$1.98
Ties	1.34	4.02
Fastenings	.72	.06
Ballast	1.30	.86
Laying	.36	.14
Total	$7.08	$7.06

* The following table of comparative cost per yard is interesting.—(TRANSLATOR.)

The wear of rolling stock is certainly less with longitudinals than with wood cross ties, but the economy due to this is found to be reduced by the effect of the uneven motion occasioned on tracks with longitudinals by the slight rigidity of the cross tieing. Nevertheless, regular observations made in Germany showed that the tires of engines running only over longitudinal systems of track were worn only one-third as much as those of engines running only on tracks with cross ties.

Track on longitudinals, while easy to lay on tangents, requires considerable care and attention for laying on curves; it is necessary then to bend the longitudinal to the required radius (an operation that can only be done while the metal is hot, and that requires special plant), or to have special apparatus for drilling the holes for the rail attachments for each radius of curve adopted. Herein is a serious drawback. Either a special, costly and cumbrous plant must be maintained or it

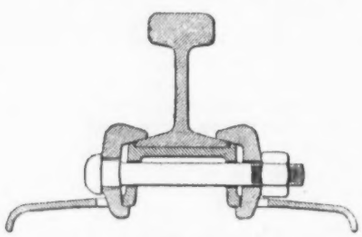


Fig. 13.—Haarmann.

may be necessary to have in each storage depot a large number of longitudinals for each radius of curve existing on the line. The regular maintenance of the track is difficult; it requires an even ballasting which must be constantly attended to, for it does not keep in order. Besides, when it becomes necessary to replace a broken or damaged rail or longitudinal, serious difficulties are experienced

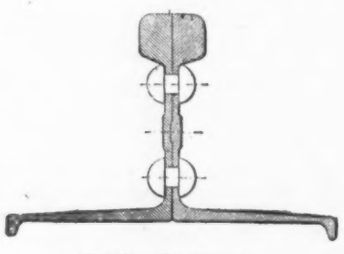


Fig. 14.—Haarmann.

owing to the necessity of making the change between the passage of two trains, this is especially difficult if the joints of the rails and ties do not correspond. The longitudinal system, owing to the weakness of the cross tieing, has a tendency to cause derailment; the track spreads, the rail shifts, and when a thaw happens, when the track is least stable, the derailment occurs. These accidents are always more serious than with cross ties. In fact, however strong these tie rods may be, they have not sufficient strength to bear the load of an axle. They bend, therefore, and drawing the two lines of rail together, help to increase the distortion of the track.

Experience has also shown the absolute necessity, for the good condition of track on the longitudinal system, of a perfect drainage of the road-bed; water must not be allowed to lie in the ballast, as it has a tendency, especially on grades, to follow the lines of the longitudinals and thus to help to destroy that regularity of the ballasting which is so necessary. In Germany special arrangements have been made for draining tracks on this system; on

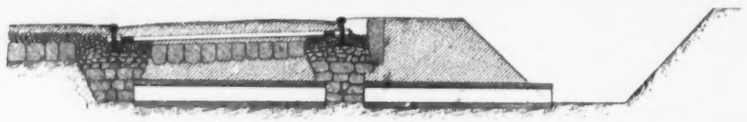


Fig. 17.—Hartwich: (Alsace-Lorraine.)

the Alsace-Lorraine railroads, which employ the Hartwich track, (Fig. 17) each line of rails is placed on a longitudinal rubble drain, every 16.4 feet these drains are connected by a cross drain running into the lateral ditch; such drainage works largely increase the first cost of tracks laid on longitudinal ties.

TO BE CONTINUED.

Regulations for the Engineering Department of the South Pennsylvania Railroad during Construction.

(*Concluded from page 41.*)

VII. Inspectors and Time Keepers.

1. Division Engineers will be authorized, when it appears proper to the Chief Engineer, to employ inspectors for Important structures. Such Inspectors shall receive orders from and report directly to the Resident Engineer. Division engineers will instruct their Residents as to the duties of Inspectors.

2. Each Division Engineer may, by like authority, employ a general Time Keeper, whose duty it shall be to keep a correct record of the labor and machinery employed on the work, properly classified and located, the wages paid, material expended, and other notes concerning the progress of the work and the Contractor's outlay.

3. The Time Keeper shall act under the immediate orders of the Division Engineer. Resident Engineers and their subordinates should be instructed to co-operate with him, and he shall have power to employ additional help, subject to the approval of the Division Engineer, in the event of their assistance proving inadequate.

4. He should report weekly to the Division Engineer, and hand in a monthly statement of the force account of each Subdivision, properly distributed, for reference by the Division Engineer to the Residents.

5. Resident Engineers and their subordinate should be so constantly on the line as to obtain an independent force account, approximately correct, for themselves. This they shall do, for comparison with that furnished by the Division Engineer, should a general Time Keeper be employed; and, in case of any unaccountable discrepancy, call his attention to it.

6. Division Engineers shall make monthly returns of force accounts, with their monthly estimates to the Associate Engineer, after a form provided by the Central Office.

7. Division Engineers shall keep a book of force accounts, showing the items properly classified and distributed, and will compare and harmonize notes with the Residents when making up the Road Section Records herein prescribed, (VI, 12.)

VIII. Estimates

1. On or about the 27th of each month, Resident Engineers shall take measurements and make an estimate of the work done on each section of their respective Subdivisions during the month current, statements of which estimates they shall prepare in duplicate on prescribed forms, one copy to be retained, the other to be delivered to the Division Engineer not later than the first day of the month following that to which they refer.

2. Division Engineers shall prepare like estimates of the work done on each section of their respective Divisions in quadruplicate, and send three copies, duly authenticated, the Associate Engineer, not later than the fifth day of the month following that to which they refer, accompanied by a force account, a recapitulation of work after such forms as may be provided, and abstracts for the progress profile hereinbefore described, (VI, 9). One copy of the estimate sheets and accompanying papers, excepting progress data, will be retained on his office files.

3. Quantities greater than those due to the net measure, as defined by the slope staking, the masonry plans or prescribed tunnel sections shall not be allowed in either the monthly or the final estimates; provided, however, that any extra expense incurred shall be clearly the result of slovenly conduct or violation of orders. If unsuitably slope-staked, if drawings are erroneous, or if slips occur in cuts and falls in tunnels from causes not reasonably to have been forecast and prevented, the extra work done may be covered by estimate, under instructions from the Chief Engineer.

4. In classifying estimates, the quality of masonry and the character of material removed, as described in the specifications, shall be regarded exclusively of all other considerations. If any case of losing merit occurs employés in this Department must bear in mind that such case is for the judgment and the action solely of those who pay the money, the Engineer's duty being rigorous adherence to the requirements of the contract and specifications.

5. No employé of this Department shall be interested in any contract, or in the furnishing of Contractor's supplies on the line of the road, or in any business connected therewith excepting that of the Company.

IX. Accounts, Supplies and Sundries.

1. The pay-rolls and expense accounts for each month shall be prepared by the Division Engineers and transmitted, with their endorsements, on or before the fifth day of the month following, to the Associate Engineer.

2. After approval in the Central Office, checks will be sent to the Division Engineers for each individual to whom payment appears to be due, and the receipted pay-rolls and expense vouchers shall then be returned to the Associate Engineer.

3. Division Engineers shall book the salary and expense accounts of their respective Divisions in the usual form, and shall report all discharges, appointments and transfers to the Associate Engineer at the time of such transactions.

The fixed salaries of the employés of this Department shall be in full for all service and personal expense, excepting necessary outlays on the Company's business, for transportation and subsistence, by Division Engineers or their Draughtsmen when called away from Division Headquarters, and by Resident Engineers or their subordinates when called away from their Subdivisions.

5. Division Engineers shall make formal requisition on the Associate Engineer for necessary equipment and supplies. They shall keep a record of all Company property in their charge, and make report thereof quarterly, with inventory of articles on hand at date of previous report, received since, expended, in what manner or service, and on hand at date of current report, adding explanatory remarks.

6. Under the head of incidental expenses shall be included, and itemized, minor outlays for stationary and printing, office rent, fuel, lights and attendance, tools and repairs thereof, postage, telegraph and express charges messengers on special errands requiring certainty and dispatch, and such small stores, needed in the progress of the work, as can best be obtained on the ground. In these matters, and in the conduct of their charges generally Division Engineers are expected to practice a watchful and rational economy, and to exact it of their subordinates. Incorrect estimates, slovenly records, laziness, drunkenness, erroneous field work, bungling use of instruments to their injury, squandering of road supplies for private account and the like should be followed by quick riddance of the culprit.

7. Offices should not be lounging places; and great care must be taken that no unauthorized persons have access to books, papers, or other information relating to the work.

8. No person appointed to or discharged from the Company's service in this Department, shall be allowed expenses to or from the field of service.

X. Miscellaneous Instructions and Suggestions.

1. In slope staking, when material is doubtful, stake for rock. In such cases, and in cases where earth cuts are started vertical, have a force to follow closely with trimmed slopes, to avoid irregular breaks and slips. Set side stakes every 50 feet for trimmers. After stripping rock restake for it. Leave a berm of 4 feet between foot of earth slope and crest of rock in mixed cuts.

2. All curves should be slope-staked at intervals of 50 feet.

3. Where cut is in excess, have it wasted regularly along the convex side of curve in adjacent fill, unless the possibility of flattening the curve in future makes it expedient to waste on the concave side. Waste symmetrically on tangents; if single track, on double track side,—subject to the condition that no overhaul shall be required and no increase of masonry, except by warrant from the Central Office.

4. Where fill is in excess on single track, first double track the adjacent cuts for a supply, if earth, and within overhaul limit. Should more material be needed, widen earth cuts to their utmost, leaving in every case room for berm ditch and additional 4 feet for fence berm.

5. Waste no material above grade unless imperative and authorized by the Division Engineer. Where material is permitted thus to be wasted, leave in every case a berm of not less than 10 feet, and additional allowance for future extra track.

6. Be vigilant to prevent trespass on adjacent properties in making side ditches, spoil banks, or otherwise.

7. Side and berm ditches should be opened in advance of graduation and kept open. Material from berm ditches should be ridged up regularly on down hill side; that from side ditches deposited in embankment. See that the outfall from ditches in cuts is turned aside so as not to scour the fills.

8. Where stream channels are changed the new channel should be side sloped, and a berm of 12 feet, with allowance for future extra track, left between its crest and foot of embankment.

9. On bare slopes, to be embanked, plow the ground lengthwise before filling in; and on very steep hillsides excavate terrace benches to hold the embankment.

10. Examine embankment sites for springs and have them carefully drained clear of the formation, by ditches filled with broken stone or cobbles.

11. Finish all earth, or mixed embankments, full width at top and 4 per centum of the record center height above grade for the reception of ballast; rock embankments 2 per centum. This is tentative and subject to modification. It is believed to be sufficient allowance for embankments made in layers or with scraper, and approximately correct for heavy dumped work on good bottom, which, advancing more slowly, must needs have gotten its bearings, in some measure, before completion. Division Engineers are invited to give their past experience on this point, and also to profit by their present opportunity for more knowledge concerning it.

12. In rock cuts see that no large masses, dislodged by blasting, are allowed to remain on the slopes or overhanging them. Examine all such masses with bars, and, where liable to be washed or frosted down, have them removed and duly entered in the estimates.

13. Require rock cuts and tunnels to be taken out full width and depth at once, and suffer no bottoming to be left over except by special permission of the Chief Engineer, in tunnels only, for the purpose of drainage during construction.

14. See that the road is graded true to line and as staked out; that material needed elsewhere is not wasted at mouths of cuts; that side slopes in excavations are plane surfaces, not convex; that embankments are carried out the full width due to the slope-staking at whatever level built; that their slopes are plane surfaces, not concave; that they are built in layers back of all abutment and culvert walls; that the centers of arch culverts are allowed generally to remain until the embankment has been carried by them; and, if removed, that the embankment is built in layers a proper height above crown or arch.

15. Approaches to crossings, in excavation or embankment, should be graded not less than 12 feet wide on top, and up to the height of top of rail—say 2 feet above grade of formation; they should ramp, or slope, at a rate not exceeding one in ten, and be level a sufficient distance each side of the railroad to prevent the possibility of stone or timber trucks stalling on the track.

16. Meeting grades should be rounded off with vertical curves at least 600 feet long; and as much longer, especially in the case of pockets, or synclinal grades, as economical conditions will permit. Special instructions will be given on this subject.

17. Be cautious not to allow full measure in monthly estimates before the work is settled, surfaced and trimmed; a safe reserve should be held usually for such items.

18. In retracing line during construction, or after graduation, use the original turning points established on the final revision of the line.

19. Timber and brush should be cleared the full width of Right-of-way and valuable timber piled up along the Right-of-way and saved for the Company, where the clearing is done by the Contractor. Trees on abutting properties, whose accidental fall might cumber the track, should be legally condemned and felled.

20. Avoid small openings in the road-bed, using box or arch culverts preferably.

21. The road-bed should be trimmed to a crown of 3 inches above grade in the middle to promote lateral drainage under the ballast.

22. Sound doubtful foundation pits with an iron rod and make sure of a good bottom. Drain them when feasible. Where not liable to wash, or to subsequent exposure, 2 feet of gravel, shingle or broken stone, well rammed, makes an excellent foundation course.

23. See particularly to the deep and safe founding of walls and curbs at the outfall end of drainage structures.

24. Before sizing openings for culverts and bridges search the water down stream, for some point where flood volume is well marked, and work by that.

25. Observe and report streams suitable for water supply.

26. Insist on specification requirements in masonry. Make it clearly understood that no excess of neat work beyond scale plans will be estimated. No crushable chips. No grouting unless authorized. Flush up solid instead, with mortar as stiff as it will work readily. Good bond imperative, and to take precedence of outside looks.

27. Clear away the surplus stone and wreckage from Masonry sites after the jobs are done; and, before the completion of each section, have blasted rock, and all other cumber accumulated during construction, removed from adjacent properties and highways.

28. In establishing outside tunnel lines by daylight the best time has been found to be just after sunrise, and the best sight pole a ¼-inch round iron rod painted white. Plummet lamps, on clear calm nights, have given better results than sight poles by day, being distinctly visible at long distances.

29. To transfer line down a shaft, set transit point at a distance therefrom of about 25 feet, from which point, with a long foresight, two staples, or other guides, may be ranged on the side timbers overhanging the pit, and the center lines thence plumbed to the bottom with fine copper wires, bobbed as heavily as they can bear, the bobs immersed in water. It has been necessary in some cases to box in the wires, to protect them against water and air currents. Careful manipulation, patient and repeated observations, and a discreet average of them are required for a correct transfer.

30. The range at bottom must be transferred to wooden roof plugs, in which eyescrews, staples or other suitable fixtures are ranged, and from which plummet lamps may be hung when required.

31. Bench marks are established similarly in the roof, being stubs of steel fastened into holes or chinks, the elevations of which are obtained by means of a reversed rod. The levels may be transferred from the surface with a steel tape or wooden rods.

32. All center points and bench marks should be placed out of danger from rocks thrown by blasting.

33. Standard measures should be made at the outset by which to test, from time to time, the tapes, level rods and other field measures used on the work, as it is important that these measures be uniform, and guarded against change.

34. For leveling underground a target with a diamond-shaped opening in it has been found convenient, one of the diagonals of said opening being horizontal. The rod is plumbed with a portable level bubble made for the purpose, and a light is held behind the target at the time of observation.

35. Division Engineer will supplement these general memoranda as to tunnel surveying, and will find room for their ingenuity in expanding and diversifying them to suit various practice.

36. Require Tie-Contractors to pile the ties regularly, both ends visible, and spaced suitably for inspection, within not less than 15 feet nor more than 40 feet from the center line of double-track road-bed, and not over 2 feet below grade, when the nature of the ground will admit of compliance with this rule. When it will not then require them to be delivered and piled where they can be conveniently got at by the track-layers.

37. After track-laying, and before opening the road to traffic, a flat car should be run its whole length each way, with templates, fixable crosswise, for testing the clear widths of rock cuts and dimensions of tunnel sections. Every point encroaching on the standard section should be marked with red paint from a large "whitewash" brush, and removed promptly by a floating gang.

38. The terms "grade line" and "grade," as herein used, refer to the surface of the road-bed, at the established profile grade; that is to say, to the bottoms of cuts and the tops of fills, as prepared for the reception of any crowning to promote lateral drainage and of the railway proper, or superstructure, comprising ballast, ties and rails. The term subgrade is omitted, as surperfluous and confusing, and is not to be used on this road. The elevations of bridge seats, bridge structures and their parts, foundations, piers, trestlework, rails, cross-ties, and all other details requiring such reference shall be referred to the elevation of "grade," by plus and minus signs.

39. Some of the rules contained in this article are intended to be suggestive rather than mandatory—practical hints and instructions. Division Engineers and all others concerned are invited to report any discrepancies, errors, or deficiencies, which they may observe, either here or elsewhere, in the present compilation, and to suggest what they judge to be improvements, corrections, or useful additions. Regard any rules as invalid which may appear to conflict with provisions in the contract and specifications, or to call for expense not therein contemplated.

WM. F. SHUNK,
Associate Engineer.

APPROVED:

ROBT. H. SAYRE,
Chief Engineer.

GUTEHOFFUNGS-HUTTE, ACTIEN-VEREIN AT OBERHAUSEN (GERMANY).—The report for the past business year states that the coal production was 696,099 tons, against 643,509 tons in 1884-85, an increase of 8.17 per cent. The blast furnaces produced 166,541 tons of pig-iron, against 164,984 tons in 1884-5. The rolling mills at Oberhausen produced 5 per cent. less, and the steel works at Neu-Oberhausen 1.6 per cent. less. The Oberhausen rolling mills produced 17.8 per cent. less finished goods than in the previous year. The bridge-building workshops delivered 6,521 tons against 7,514 tons in 1884-85, including bridges for the Piræus Railway, bridges for Oberhausen, lockgates for Egypt, and various bridges for home railways. The production of the boiler shops was 1,277 tons, against 1,217 tons in 1884-85. The steamship building establishment at Ruhrort employed on an average 160 workpeople, against 154 in the previous year.—*Iron and Coal Trades Review*, December 17.

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EDITORS.

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As above announced Mr. A. M. WELLINGTON has arranged to assume his position as editor of this journal, jointly with Mr. D. Mc'N. STAUFFER, from the present issue. Such a change in the organization of the paper, accompanied as it is by further enlargements of its staff, and scope of the paper, which its past prosperity not only justified but demanded, would naturally seem to call for some declaration as to its future policy, but as we stated last week in giving notice of this coming change, we prefer to develop our plans by deeds, rather than words. Suffice it to say, that we expect hereafter to be able to cover the whole field of engineering far more completely than ever before, for engineering is becoming daily a more and more important interest, both absolutely and relatively. ENGINEERING NEWS expects, and intends to advance with it, and even faster, in the future as in the past.

The Inter-State Commerce Bill.

The inter-state commerce bill is now practically a law, and certainly since the days of the civil war no beginning has been made toward so great a change in our customs of government, nor one so likely to profoundly affect the welfare of railways, and hence of a large percentage of engineers. The power which was only conceded to the general government after a fierce debate in the Constitutional Convention but which has yet lain practically dormant ever since, has for the first time been assumed. Such revolutions rarely go backward, and we may be tolerably sure that it is only the beginning of a permanent supervision of inter-state commerce—more or less extended and rational--by the general government.

As a whole, the bill appears to approach far more nearly to a satisfactory and beneficial measure than was likely to have come from a first attempt of Congress. With its usual perspicacity the daily and weekly press, for the most part, confines it attention to more immediate effects, or talks all around the subject in a very gingerly way; but we, as engineers—vitally interested in the permanent well-being of our public works, but with little further interest in corporations as such than to wish to see every man get his own—can afford to take a little larger view of the situation, and look beyond the immediate details to the probable ultimate result.

This, we predict with some confidence, will be almost unalloyed good. The two most objectionable features of the bill are the "long and short haul" provisions, and the prohibition, of pooling. In the hands of an ignorant or reckless commission both of these provisions might work great harm; but we may reasonably hope both that the commission will not be such, and that if it is, the sense of responsibility and the "fierce light" of public opinion—both of which will be vastly more effectual checks on a national than on a state commission—will make their actions judicious, if not their intent.

If so, the whole danger of the long and short haul provision is taken out of it by six little words "*under substantially similar circumstances and conditions.*" It would be hard to find any two shipments from different points which could in strictness be said to be under "substantially similar conditions," so that if reason and good sense govern the action of the commission nothing more is likely to result than the correction of some few real hardships, leaving the vast majority of cases, where the apparent discrimination is necessary and equitable, practically unchanged. If the wording of the law had been reversed, so as to read "no common carrier shall charge any *less* compensation for a *longer* than for a *shorter* distance" which would in no way alter its real substance, it would have been clear to every one, as is the fact, that such discriminations are no more desired by the railways than by the public if it can be avoided, *i.e.*, if the conditions are in fact "substantially similar."

The pooling provision seems to threaten more danger, for the pool, as compared with the anarchy which prevailed before, was an immense advance, and were the only alternative to their abolishment a return to former conditions, as no doubt many who have favored the bill desire and intend, it would be like a return to barbarism. But we hope at least that this is not a probable result. It will not be the first time that men have "builded better than they knew", and reached a right conclusion from many premises.

The root of the difficulty which the bill is likely to cure, and to be in the end a benefit to all, is that, without any fault of their own, the railways have out-grown both the protection, and the control of the law. In the eyes of the law, common carrier John Stokes who drives the Podunk stage, and common carrier Pennsylvania Railroad, stand on the same footing as simple persons, one a natural person and the other a legal one, but really they stand on a very different footing. The heavy hand of the law can reach John Stokes through the nearest justice of the peace, both to protect him in his rights—for protection, and punishment must go hand in hand—and to punish him for his wrongs; and the equities in his case are so simple, that the heavy mind of the law, as represented by the aforesaid justice, can properly comprehend, so as to enforce them. But the law can do practically nothing to protect the Pennsylvania Railroad in any one of the twenty States, to which its interests extend, because it cannot protect them in all; while it can do almost as little toward laying its hand upon the pulpy individuality of so vast an organization, to punish or control its wrong-doing.

In other words, a few dozens of corporate persons, of vast power and vast wealth, have grown up within the State, which are greater than the State itself, and beyond both the protection and the restraint of the law. What has happened? The strong good sense and the law-abiding and equitable disposition of our race have shone out conspicuously in our railway managers. They have shown, as did the early pioneers in California, that when the forms of law failed, they could govern and control themselves, and have organized a marvellously efficient, economical and equitable railway service, with marvellously few abuses. Not without reason has it happened that in America and England alone, the people have been left to carry on their railways without govermental control. In America and England alone, could the people be so trusted, and while the result in England has not been so entirely satisfactory, in America it has been very wonderfully so. The people have been well served, and their interests well guarded. Where there has been injustice, it has rarely indeed been deliberately planned, and they have often asked and secured far more than justice. A curious proof of this is the way in which local rates do in fact fall in almost exact proportion to the through rates, if we had space to present the facts.

Nevertheless, there have been and are difficulties. Because of their anomalous relation to the law the corporations have been compelled to sustain to each other, to a large extent, very similar relations to those of Bill Nye to his friends. They were "men of peace and they *would have* peace, if they killed every man in the room." There being no common superior to which they could effectually appeal, not even an organized public opinion, they have been really compelled to fight for their rights, in many cases. They have sallied out upon each other in repeated instances like robber barons of old, and for much the same reasons,—not that they loved fighting for its own sake, but because there was nothing but a fight to appeal to and no evidence but suspicion as to what the enemy was plotting. Nevertheless, these conditions could not fail to call out a pure love of fighting in many cases. Responsibility without power is bad enough, as many an engineer knows, but

power without responsibility is infinitely worse, and many a "General Passenger and Freight Agent," and president too, has waded into the fight *con amore*, mistaking combativeness for a sense of duty; armed with the power of millions in each hand; firmly convinced for the moment that it was his duty to shed the last drop of his stockholders' blood before he would give up his point, and finally resolved to "to do his duty," who would have had a new revelation of duty had he been fighting with hundreds of his own money instead of millions of other peoples'.

When we see what determined recklessness men will show in fighting even with their own money, it is certain that this must have been so in many cases of railroad fighting with other peoples' money, and it will be to the immortal honor of our railway managements that, deprived of all effectual protection as they were, and weilding such enormous power, there has been so very little fighting, and that little so comparatively harmless and soon over. But from this lack, and not from natural cussedness or lack of justice have come most of the abuses at which the Inter-State Commerce Bill is aimed, and to control which pools were instituted; such as secret drawbacks, preferences to one individual or one locality over another, refusal of reasonable interchange facilities to the serious inconvenience of the public, and secrecy in rates and accounts. They were each afraid that if they did not jump in to take every advantage their competitors would; and so each committed acts which really justified their competitors in breaking the most solemn agreements almost as soon as the ink on them was dry. The bare-faced way in which some roads would do this was long a scandal and reproach from which the pools have largely saved us.

If abolition of pools meant a return to these conditions it would be an unmixed evil. But we do not see that it will. The new law called into action the only power which is greater and more far reaching than the great modern corporations; the power of the general government. The corporate as well as the natural person needs such a power to overshadow him, both as a protection and a check, and not so much for its actual as for its *potential* power of interference.

The law interferes with few of us, but it controls us all. It transforms the good-hearted and well-meaning but lawless and violent frontiersman into a quiet, law-abiding citizen. For precisely similar reasons it is at least highly probable that a National Commission will have a similar effect in corporations, and so do away with most of the necessity of pools, which after all are a somewhat crude device, although the best heretofore available. For railway companies do not carry for less than cost, nor for one man or place cheaper than another, or keep secret their rates and then secretly undercut them, because they like to, but because they think they have to, to keep even with their competitors. Let it once be understood that it will be both difficult and dangerous to do that sort of thing, because the heavy hand of Uncle Sam might come down on the offender, armed for the occasion, and the strong, good sense and natural preference of our managements for quiet, equitable methods will do the rest. The heavy hand aforesaid will have very little to do, especially if reason and justice guides what little it does do.

The pool is a crude device because it has some tendency at least to do away with the evils of competition by abolishing competition altogether. Now there are two ways of competing, to render the same service for less money, and to render a better service for the same money, or at less cost. The first is bad, but the second is good and healthy. If it is possible—and we think it is at least that—for the organized, moral influence of the general government, assisted as it will be by the mutual watchfulness of the corporations, and backed as it is by resistless power to effectually stop the first and leave the second to act unchecked, it will be much better than pooling. To mention only one desirable improvement which still remains to be made, the time of transit of freight is unconsciously long and irregular. If railways can only be relieved of all fear of improper wars and rumors of wars by the only power which is stronger than all of them put together, and be left to get what business they can by *legitimate and healthy* competition in the quality of the service, and in *known, public and universal* changes of rates, the effect may be very healthy. It may not—and probably will not—come about all at once, but we think it may come much sooner than is expected. The different effect of having the national government and a state government behind a commission is not sufficiently allowed for.

As respects railroad construction, it seems to us that the effect of the bill will be still more certainly healthy. It will check the wild exuberance of competitive construction in time of activity, while by its steadying effect on railway business it will not leave construction to fall off so "dead flat" in times of depression. Engineers and contractors, above all men, will profit by such a change, and they may reasonably hope for it.

Some Further Data about Steam Heating Plants.

Mr. George H. Babcock, President of the Babcock & Wilcox Company, presents the following empirical rule for determining the proper amount of surface required in radiators, in the direct system of steam heating.

Add together the square feet of glass in the windows, the number of cubic feet of air required to be changed per minute and one-twentieth the surface of external wall and roof, in square feet; multiply this sum by the difference between the required temperature of the room and that of the external air at its lowest points and divide the product by the difference in temperature between the steam in the pipes and the required temperature of the room. The quotient is the required radiating surface in square feet.

Mr. Henry R. Towne, President of the Yale and Towne Manufacturing Company, in a recent volume of the Transactions of the American Society of Mechanical Engineers, records an interesting expedient adopted by him, for increasing the humidity of the air in houses. He had observed, by using a Mason's hydrometer, that, in ordinary winter weather, the percentage of moisture in the house, warmed by the indirect system of steam heating, was under forty per cent, and from that down to thirty, while the proportion considered desirable from a point of health should be at least sixty per cent., and even more.

To remedy this defect, he made a connection with the steam pipe at several of the box coils under the floors, where the inflowing current of air is passed through the coils to be heated, and by means of a regulating valve on the floor, he could cause a jet of steam to issue just under the radiator at a point where it mingles with the inflowing air. He could open the valve so wide as to get a visible flow of steam through the register, if desired; and he could, at will, increase the moisture of the air up to the point of saturation; the amount of steam so introduced being simply limited by the point at which condensation on the windows occurs. This begins to take place when a humidity of sixty per cent. is reached.

Mr. Towne reports that the difference in the atmosphere of a house resulting from a proper moistening of the air is greater than any one appreciates who has not tried the experiment, and he accordingly, strongly advocates a general introduction of a device of this kind.

Since Mr. Towne has advanced this scheme, certainly one firm of manufacturers of steam heating plants—we believe also more—have put on the market suitable simple devices embodying this idea.

In the same volume, but not the same discussion, Mr. Towne, adopting the plain horizontal tubular surface as the standard unit of surface, and referring to the actual measurement of the external surface of any steam-heated pipe, tablet, fitting or hollow object, and of any pins, ribs or plates solidly attached thereto, calculates only 85 per cent. of the vertical surface, and 80 per cent. of all surfaces having pins, ribs or plates as a part thereof, as an equivalent estimate to plain horizontal tubular surface. This, of course, accords the greater efficiency to the plain horizontal tubular surface, so that one hundred square feet of vertical tube will, under this ruling, be only estimated as 85 feet (horizontally placed) available for heating.

If the heat present in the exhaust steam of engines is sufficient to warm the building, it is, generally speaking, more economical, in factories and other establishments where power is generated, to utilize the exhaust steam in this way than in any other. The cost of extra back pressure thrown on engine is usually small as compared to the advantages secured. Of course, connections should be provided, so that live steam from boiler can be used for heating the building, if desired.

Steam heating boilers not in use and idle during the summer, should, after being thoroughly swept and cleaned, be kept entirely full of water. Inspection should be made, from time to time, to see that the boiler is full, and boiler be filled if any loss of water is discovered. When this or some equally good expedient is not adopted to prevent the intermittent action of moisture and air on the surfaces of the metal, and consequent rusting, the deterioation of the boiler will be found to be far more serious in summer when idle, than when in use in the winter.

The Geological Survey of Pennsylvania.

The Board of Commissioners of the Geological Survey of Pennsylvania have sent in their report for 1885 and 1886 to date of January 1 1887. The field work for 1885, was carried on mainly in the oil and gas regions, a map of Western Pennsylvania was constructed showing the outlines of the oil and gas pools, and special investigations were made as to the relative positions of the various sands producing gas, the depth of the oil and gas sands below the surface in different regions and finally a general investigation into the pressure, quantity, composition and fuel value of the natural gas. In the Pittsburg and Monongahela bituminous coal regions a revision of the surveys of the entire district was commenced and special maps constructed. In the anthracite coal regions the surveys were extended and a number of others completed since July, 1885, Mr. Peter Lesley, the State Geologist, has been engaged in preparing a summary or final report on the geology of the whole state.

In 1886, the oil and gas surveys have been extended, especially into Washington and Greene counties, and a new oil-and-gas map constructed. The statistics of the production

and shipment o since 1859 have also been collected. For the Pittsburg and Monongahela bituminous regions a new map, on the scale of two miles to the inch, will be published early this year. Improved methods of mining bituminous coal will also be fully reported together with plans of tools, machinery and mine plans. In the anthracite coal region a new map of the entire district has been made showing each individual colliery.

Much work yet remains to be done, owing to reduced apropriations in late years. Fourteen counties are yet lacking in the series of colored geological county maps on a scale of two miles to the inch. And of thirteen counties no full geological reports have yet been prepared; a number of special surveys are also necessary. The proper survey of the anthracite coal region is only half completed; this section containing more unfinished work than any other in the state. The topograpical survey covers about 4,000 square miles now and should be continued, and accurate statistics gathered of oil, gas, iron, bituminous and authracite coal, limestone, building stones, clays, etc. The Board of Commissioners recommend an appropriation of $90,000 for the next two years, one-half to be expended in each year.

"The Longest Tunnel in the World."

The Journal of the Austrian Society of Engineers and Architects says the longest tunnel in the world is at Schemnitz in Hungary. This is a drainage tunnel 10.27 miles long and 9 feet 10 inches high by 5 feet 3 inches wide. Its construction was agreed upon in 1782, to be finished in 30 years; but owing to the French Revolution and other hampering incidents, it lay idle for thirty years, was then actively pushed for ten years and was again abandoned for 20 years. It was finally completed in 1878 at a total cost of about $5,000,000. The original estimate was about $35 per lineal yard; this rose to $170, and the final work cost $110 per lineal yard.

While this is undoubtedly a lengthy tunnel, one mile longer than the St. Gotthard and 2½ miles longer that the tunnel at Mt. Cenis, it sinks into insignificance beside the 30 miles of the New Croton Aqueduct tunnel now being driven in this vicinity. The Croton tunnel will be very nearly 30 miles long, and 22 miles are already driven, though work was only commenced in January 1885, the contracts being awarded on December 13, 1884. The general section is also much greater than the Schemnitz tunnel, being about 16 feet diameter. While the Croton is not a railroad tunnel through a vast mountain range, and is of local value rather than general commercial importance; yet it can fairly claim the credit of being the "longest tunnel in the world"; and this is especially true when it has to combat the claim of a rather small drainage tunnel like the one referred to.

New Civil Engineers and Surveyors Societies.

A Civil Engineers' Club has been formed in Kansas City, Kan. The following engineers were present:—

Messrs. O. Chanute, W. B. Knight, F. W. Tuttle, W. H. Breithaupt, J. A. L. Waddell, K. Allen, D. W. Pike, F. Tuttle and C. E. Taylor. A committee was appointed to draft a constitution, etc.

The Convention of County Surveyors of Illinois decided on January 19th to form a permanent organization under the name of the "Society of Surveyors of the State of Illinois." Thos. S. McClanahan was elected President; J. T. Foster, Vice-President and Geo. Dickson, of Alton, Secretary.

The Healthfulness of Land Reclaimed from the Sea.

The *Giornale del Genio Civile*, 1886, p. 163, says that in connection with the proposed drainage of the Ostia and Maccarese marshes in Italy, the question of the relative healthfulness of such reclaimed land has been investigated.

In the cultivated lands bordering the Venetian lagoons, it is found that reclaimed land once freed from the salt suffers no injury from the net-work of salt-water canals intersecting them. When the sluices are of ample size and a circulation secured by passing the water in at one portion and out at another the region is healthy. But if this precaution is neglected and the water allowed to become stagnant, fever at once appears. This has been tested thoroughly by special commissions.

There is no doubt as to the productive value of reclaimed lands; but there is some uncertainty as to the time required to get entirely rid of the salt. This depends to some extent on the soil; if sandy, cultivation can be commenced as soon as the salt-water is excluded. But in clay-land some time must elapse. A fair yield can be promised generally after a year or two by beginning with suitable seed.

In the Netherlands it is a recognized fact that an extensive reclamation of land frequently causes temporary outbreaks of fever; but as the land dries up, these disappear and the health of the country is permanently improved.

Blasting Without Explosives.

Dr. Kozman, in the *Oesterreichische Zeitschrift für Berg und Hutenwesen*, 1886, p. 178, describes a substitute for the usual explosives in fiery mines. He suggests cartridges of zinc-dust (as found in the condensers of zinc retorts) and diluted sulphuric acid. The case of the cartridge is a glass cylinder 7 inches long, by 1-inch diameter, with a contracted neck dividing its length as 1 is to 4, the connecting opening being only about $\frac{3}{16}$-inch diameter. The lower and larger division is filled with diluted sulphuric acid, and a plug of cork or gutta-percha put in the neck.

When used the upper part is filled with zinc dust, and a shooting-needle passed through the dust to the plug. The shot-hole is loaded and tamped in the usual way, first with tempered and then with dry clay or shale broken up; if the rock is porous the hole is carefully clayed first. The "firing" is done by several sharp blows on the shooting-needle which then drives out the plug, and breaks the neck in the cartridge-tube, and thus allows the acid and zinc-dust to mingle. A rapid but not instantaneous evolution of hydrogen takes place with about the following expansive power:—

A cartridge 25 millimetres (.98 in.) in diameter and 180 millimetres (7.08 in.) long contains approximately 90 cubic centimetres (5½ cu. in.) The charge consists of 50 cubic centimetres (3 cu. in.) of sulphuric acid, and 12 grams (.42 oz.) of zinc-dust, which will in the average commercial mixture contain 10 grams (.35 oz.) of metallic zinc. The volume of gas evolved by the chemical mixture, will equal about 3.37 cubic metres (119 cu. ft.); and this divided by the confining space will represent about 37,000 atmospheres in round numbers, or more at the higher temperature usual in mines. The pressure from gunpowder in blasting is below 5000 atmospheres.

As to the danger to be apprehended from the sudden release in the mine of a large volume of hydrogen, the author thinks that it will be diffused so rapidly that the inflaming power will be practically lost. The heat developed by the acid acting on the zinc also causes considerable steam which will lessen the explosive power. It has not been tried on any large scale.

PERSONAL.

HENRY D. MYERS, one of the oldest civil engineers in Poughkeepsie, N. Y., dropped dead in that place on January 22nd.

Mr. KING, City Engineer of Fort Worth, Tex., has been appointed Chief Engineer of the Denton & Weston R. R.

E. GRANT CHILDS, with office at Waterville, N. Y., is engineer in charge of the survey of the Beaver Creek line.

SIR FRANCIS BOLTON, for a long time official examiner of the various water supply companies of the Metropolis of London, died recently in that city.

COWPER J. THORBURN has been appointed a rodman in the Engineers' Bureau of the Department of Public Works, New York City, at a salary of $1,200 per annum.

B. H. BRYANT has been appointed Assistant Chief Engineer of the Colorado Midland R. R., with office at Colorado Springs, Col.

FRED P. CLUTE, late Resident Engineer of of the Tennessee Coal, Iron and Railroad Co. has been appointed City Engineer of South Pittsburg, Tenn.

E. H. BECKLER (not Becker as stated on page 30) has been appointed Assistant Chief Engineer of the Montana Central R. R., with headquarters at Helena, Mont.

W. W. FOLLETT and JOHN KELLY are the engineers in charge of the party who are surveying a line for the Atchison, Topeka & Santa Fé R. R. from Pueblo to Denver, Col.

H. A. PARKER is Chief Engineer of the Chicago, Kansas & Nebraska R. R., with office at Atchison, Kan.; C. W. FISHER is General Manager, at St. Joseph, Mo.; W. J. ALLEN is Division Superintendent, at Whartman, Kan.

J. A. L. WADDELL has located himself as a Consulting Engineer at 118 West Sixth street, Kansas City, Mo. He represents the Phœnix Bridge Co. and the Phœnix Iron Co. in that section, and his special practice will be in the direction of bridges, roofs and foundations.

J. C. SHANNON, Civil Engineer, recently connected with one of the English trunk railroads, has arrived in this country; he will investigate the systems of bridge building adopted here. MR. SHANNON will find considerable difference from, and superiority over, English bridge practice.

WILLIAM HENRY BOOTH, late editor of our contemporary the *Mechanical World*, of Manchester, Eng., has severed his connection with that journal, owing to an entire change of policy and shape by its proprietors. Americans will regret his disappearance from the editorial chair; for though an Englishman born, his experience as an engineer in the Colonies had taught him to appreciate the merits of American machinery, bridges and methods generally and he fearlessly advocated them on all occasions.

SIR JOSEPH WHITWORTH, the eminent English engineer, died at Monte Carlo on January 22nd. Sir Joseph was born in Stockport, England, in 1803. He founded the manufacturing firm of Joseph Whitworth & Co., in Manchester, and soon made his name prominent by his inventions and improvements in machinery. In 1854 he commenced the manufacture of the rifled cannon long known by his name. He was knighted in 1869.

GENERAL CHARLES P. STONE, whose name has been prominently before the public in late years as the Engineer-in Chief of the Statue of Liberty in New York harbor, died suddenly on January 24th. GEN. STONE was born in Massachusetts, and entered the U. S. Army as a Lieutenant of Ordnance in 1845. He served with distinction in the Mexican war; but during the civil war was, by a complication of circumstances even yet unexplained, arrested and confined for one year in the military prison at Fort Lafayette. On his release—without explanation—he rejoined the army and served with General Banks in Louisiana; he resigned from the army in 1864. He subsequently went to Egypt and served for some years as chief of staff in the Egyptian

army, receiving the title of Pasha. Returning from that country at the commencement of the late complications with England, he was soon after appointed engineer-in-chief for the commission which had in charge the erection of the Bartholdi Statue of Liberty, and remained in that position until the completion of that monument. GEN. STONE'S death was unexpected, and he had just completed arrangements for going into business in New Orleans.

CHANGE OF OFFICERS.—The death of JOHN ROACH who was President of the Chalmers-Spence Co. —of New York—well known manufacturers of asbestos goods of all kinds, left a vacancy, which was filled by the Trustees of the company on the 24th inst., by the advancement of ROBERT H. MARTIN, the former Secretary and Business Manager. Mr. GEORGE E. WEED still holds the position of Treasurer, while Mr. C. H. VAN NOSTRAND, the former managing clerk, has been made Secretary of the company. The business of this company is steadily on the increase.

JOSEPH SEWALL, of the firm of J. W. and J. Sewall, Civil Engineers, Old Town, Me., died in that town on the 16th, aged 32 years. MR. SEWALL was the son of the late Hon. Geo. P. Sewall,—and was educated at Bowdoin College; he was assistant engineer in the construction of the sewerage systems of Norfolk, Va., and Keene, N. H., and was employed as engineer-in-charge by the city of Owensboro, Ky., in making a survey of that city and preparing the preliminary plans for its system of sewerage. He was afterwards engaged under the United States Government, in mapping the built up portions of the city of Boston, and he also aided in preparing the maps for the report upon social statistics in the tenth United States census. He was mostly engaged during his later years in all sections of Maine in making topographical surveys, a branch of his profession in which he was very proficient, having probably few equals in the State. During his work in the South he contracted malarial fever which finally resulted in his death.

BRIG. GEN. WM. B. HAZEN, U. S. A., late Chief Signal Officer, died at Washington, D. C., on January 16th. GEN. HAZEN was born at West Hartford, Windsor county, Vermont, September 30, 1830. He was appointed to West Point in 1351 from Ohio; was commissioned 2nd Lieutenant in the 4th Infantry in 1855, and saw his first service on the Pacific coast. He was promoted to Captain in the 8th Infantry, May, 1861, for gallant services in New Mexico. He was Assistant Professor of military tactics at the Military Academy in the same year; but was soon after appointed Colonel of the 41st Ohio Volunteers, and was promoted to Brig. General of Volunteers in February, 1862. In 1864 he was made a Major General of Volunteers for services at Fort McAllister, and on May 19, 1865, took command of the Fifteenth Army Corps. He was soon after commissioned Colonel of the 38th Regiment, U. S. A., and afterwards of the 6th Regiment. In 1876-77 he was military attaché for the United States at Vienna during the Russo-Turkish War, and published his observations. He was appointed Chief Signal Officer in 1880, and his ruling passion for writing as a military critic carried him to extremes and into hot water with his superiors, in matters of such recent date that they need not be mentioned here.

The American Society of Civil Engineers.

It is, or should be, a matter of legitimate congratulation among all engineers that this greatest of our engineering societies is showing such vigorous and healthy growth as is revealed by the last report of the Board of Direction, as given in our last issue; for even those engineers who, as individuals, have no direct connection with the society, are interested as engineers in seeing a great national organization grow up which shall worthily represent the profession, and certainly the American Society has the "promise and potency" of doing so far more completely than any other organization.

The growth of the society was larger last year than in any other in its history, as will appear from the following figures, which show its growth in each of the twenty years since its reorganization:

From these figures it can be seen at a glance how the society has grown. Its ratio of increase in three successive periods of five years, omitting the first five years, which may be called the formative period, has been:

	1871-76	1876-81	1881-86	Last year.
Members.....	91 p. c.	23 p. c.	48 p. c.	8.4 p. c.
Total.....	106 "	25 "	48 "	9.8 "

MEMBERSHIP, 1867-1876, TEN YEARS.

	1867	1868	1869	1870	1871	1872	1873	1874	1875	1876
Members.....	28	99	160	191	215	278	329	355	371	417
Others.....	4	5	6	41	53	59	85	90	121	135
Total,.....	32	104	166	232	268	337	414	445	492	552

1877-1886, TEN YEARS.

	1877	1878	1879	1880	1881	1882	1883	1884	1885	1886
Members.....	436	454	464	473	513	565	589	657	701	760
Juniors.....	56	57	54	48	54	58	67	77	89	103
Associates.....	16	17	18	20	24	30	31	34	33	44
Others,.....	66	65	65	74	99	103	108	110	105	109
Total.....	574	593	601	615	690	756	795	878	928	1,019

INCREASE, 1867-76.

Members.....	71	61	31	24	63	51	26	16	46
Others.....	1	1	35	12	6	26	5	31	14
Total.....	72	62	66	36	69	77	31	47	60

1877-86.

Members.....	18	10	9	40	52	24	68	44	59
Juniors.....	1	−2	−6	6	4	9	10	12	17
Associates.....	1	1	2	4	6	1	2	−1	11
Others.....	−1	0	9	25	4	5	3	−5	4
Total.....	20	8	14	75	66	39	83	50	91

[The membership given is that at or very near to *the end* of each year noted.]

It will be seen, as appears still more clearly from the table of increase above, that for three or four years, six or eight years ago, the growth of the society was very slow indeed—dangerously slow. But in the last five years it has been very different. If it should simply continue at the average rate of the past five years the society will number in 1891 about 1,550, in 1896 about 2,290, in 1901 about 3,400, and in 1906 over 5,000, or stand about where the Institution of Civil Engineers does now.

To better see what these figures mean, we may contrast them with those for the growth of the Institution of Civil Engineers, which from the beginning of its history (almost) have been as follows:

	1836	1846	1856	1866	1876	1886
Inst. C. E..	254	600	797	1339	2884	5100
Increase,..		346	197	542	1545	2216
Incr. p. c...		136.	33.	68.	115.	77.

Thus it will be seen that the Institution likewise had a period of very torpid growth, but after it reached about the point where the American Society now is, it began to grow very rapidly indeed, until it attained its present magnificent proportions. "There is nothing succeeds like success" either with technical journals or technical societies. It is the snow-ball process over again. The foundation must be laid slowly, but after a sufficient number of the profession have set the fashion, so that it is clear that it is a fashion, thereafter it becomes a game of "follow my leader." So it has been with the English institution, and so it seems but reasonable to expect it will be here.

That the American Society is so fortunate as to be on the very eve of such an expansion of its growth, however, is not so clear. It is to be remembered that the years when it showed least growth were years of great depression, whereas the present is a period of great prosperity. Moreover, the organization of the Institution of Civil Engineers is radically different from that of the American Society. While the Institution was, for the most part, a society of one grade, as is the American Society, it did not grow even as fast as the American Society. In 1846 the first important change took place, with a purpose of promoting, as it did greatly, the growth of the grade of Associate. The rapid growth of the Institution thereafter was chiefly in that grade. In 1867, a still more important change took place; the grade of "Student" was established, corresponding to nothing in the American Society, unless partially to "Junior." About one-sixth of the total membership now belong to this grade alone. The still more rapid growth which then began was chiefly in this grade. In 1878, still another change was made. The grade of Associate was divided into two, those who were practicing engineers, (now usually termed Associate Members) and those who were merely engaged in allied pursuits. Thus there are now in the Institution three very active grades for engineers, Member, Associate Member and Student (the two latter far outnumbering the higher grade) and another, Associate (also a very large grade) for those who are not strictly engineers. Had the growth of the Institution been no faster than that in its grade of Member it would now number hardly one third of its present membership.

This is but natural. A Society which aspires both to large numbers and to a high standard of qualification for full membership must necessarily have its greatest numerical strength in its lower grade, and it is one of the most hopeful features of the last report of the society that it shows for the first time the beginning of a tendency to grow at the bottom. It is only a beginning, but the percentage of the junior grades in the society is now larger than ever before, and largely by the accretions of the past year alone.

It is laid down on good authority that in making a fortune the first thousand is the hardest to get, and clearly the same law should hold with societies. As the American Society has now passed that point we may reasonably hope that it will grow much faster hereafter. The membership are, we have reason to know, practically united in the desire to see all members of the profession, young as well as old, enrolled in its membership and having its benefits. The dues for the grade of Junior seem to us rather high in proportion to benefits and means, which, perhaps, largely accounts for the slow growth of the grade, but those who suffer by such defects have only to ask to have them corrected, if they are real ones, and in the meantime, if they are any young men, or old men, disposed to look askance on the American Society as a "local institution" the above figures should awaken them from that delusion, at least.

Members and Guests Present at the Annual Meeting of American Civil Engineers Society.

(*Concluded.*)

J. C. Goodridge, C. Colné, Geo. H. Frost, George H. Babcock, New York; A. P. Trautwine, Hoboken; H. C. Meyer, New York; A. G. Brinkerhoff, H. W. Brinkerhoff, Brooklyn; E. Lans, East Orange, N. J.; L. H. Jaques, U. S. N.; A. Zacherid, Paris; H. R. Bradbury, W. C. Church, R. H. McCutchen, New York; C. A. Wilson-Newark, Ohio; C. S. Van Rensselaer, New York; C. C. Waite, Cincinnati; R. H. Soule, Buffalo; M. J. Coffee; W. H. Lippincott; Wm. Roberts, Massachusetts; G. W. Cass, G. M. Phelps, Jr., G. A. Bouker, G. W. McNulty, N. L. Lacham, Julius Elson, New York; H. N. Elmer, St. Paul, Minn.; B. Godwin, New York; James Archbald, Scranton, Pa.; C. Ackenheil, New York; C. D. Van Name; C. M. Harris, George Derin, Alfred Noble, J. F. McClelland, New York; General John Newton.

William E. Worthen.

PRESIDENT AM. SOC. C. E.

(With Portrait.)

William E. Worthen was born at Amesbury, Mass., March 14, 1819; his father, Ezra Worthen, having been one of the projectors of Lowell as a center of manufactures, and the first Superintendent of the Merrimack Mills from date of June, 1822. William E. Worthen, after having been fitted for college by I. B. Hayward, of Boston, was entered at Harvard and graduated from that institution in 1838.

He commenced the profession of civil engineering under the tutorship of S. M. Felton, an assistant in the office of the then prominent engineer, Col. Laommi Baldwin; and the day after graduation from Harvard was put to work under the direction of George R. Baldwin, measuring the flow of water used at the Merrimack Mills. With Mr. Baldwin he went to Boston and was employed in the surveys and brook-measurements for an increased supply for the Jamaica Ponds water-works, a private enterprise for supplying Boston with water by gravity. He then returned to Lowell and under Mr. James B. Francis was engaged for some time in general hydraulic and mill work.

In 1840 Mr. Worthen was with Mr. G. W. Whistler on the Albany & Stockbridge Railroad, commencing with the preliminary surveys of the road and remaining until its completion, seven miles of the construction work having been under his immediate charge. Returning to Lowell he was again engaged with Mr. Francis in hydraulic work and the construction of the lower end of the Northern canal; then designed and built a dam and the mills on the Suncooke at Suncooke. He also designed and constructed a dam and mills for the Boston Manufacturing Co., on the Charles river at Waltham, and the Suffolk, Tremont, Lawrence, Appleton and Hamilton mills at Lowell. He reported on the water supply for Lowell and was in charge for a time of the cotton mills and machine shops of the Boston Manufacturing Co. as acting superintendent.

After a visit to Europe in 1849, Mr. Worthen came to New York and to some extent devoted himself to architectural work, building the structures at No. 200 Broadway, and at the same time took part in editing several mechanical publications. In 1851, we find him in charge of the cotton mills and machine shops of the Matteawan Co., at Fishkill; but returning to New York in the following year, he was again engaged as an architect, among other buildings, designing and constructing the bindery of the Appleton Publishing Co., in Franklin street, and their present works in Williamsburgh. Later he was engineer of the New York & New Haven R. R. and the Vice-President of that road, until 1854, under Mr. Robt. L. Schuyler.

He designed and built the dam across the Bronx river at West Farms; and then opening an office in New York supplemented his architectural and engineering practice by constructive iron works and steam-heating for buildings. He was engaged for a long time in general engineering work; building the dam across the Mohawk at Cohoes, testing steam pumping machinery at many points, and designed pumping engines for Mr. Kirkwood in his report on the water supply of Cincinnati and St. Louis. He devised floating grain docks, for the same engineer, at the Jersey City depots of the Erie R. R. Co., and was Sanitary Engineer of the Metropolitan Board of Health during its whole existence.

Mr. Worthen had much practice in the measurement of the flow of water in canals, reporting upon this class of work for Paterson, Trenton, Passaic and Indianapolis, among the more important. He finished the Southern Boulevard, in New York; built the first pumping engine at High Bridge, New York City; the engine at Rockville Center and many pumping engines of smaller capacity; extended the water supply of the City of Cohoes and finished the water-works of Long Island City.

As consulting engineer he has, at various times, examined and reported upon—the Indianapolis and the Hartford water-works, the condition of the docks of New York City, and the Riverside Park, the extension of the streets of Brooklyn, selection of pumping engines for Boston, etc., etc. He was engineer of the later Commissions on Rapid Transit in the Annexed District to the city of New York, and reported upon the water power of the Falls of St. Anthony, Minn.

This very incomplete sketch will give some idea of the varied practice which has occupied Mr. Worthen during a long and most active professional life, there being scarcely a branch of civil or mechanical engineering wherein his professional fitness has not been conspicuous in a marked degree. It has not been his lot to project or carry to completion great works of Internal Improvements, such as challenge the admiration of the unthinking public, but in a very unobtrusive way he has been continually rendering that essential service towards the furthering of enterprises, without which the best conceived projects would prove abortive. To a remarkable power of rapid generalization, seemingly incompatible with painstaking accuracy, he unites an almost intuitive perception of the requisite expedients of detail and design. His quickness in technical analysis, combined with the before mentioned qualities has rendered possible the successful completion of many important works with which his name is scarcely associated. A retentive memory, to sift and treasure the facts in science and art that extended study has opened up to him, the tact of judicious selection and application, originality and boldness at times bordering on audacity, and a positiveness that silences all opposition, have been the characteristic features of his long practice.

The American Society of Civil Engineers, in electing Mr. Worthen as its President for the present year, has made a most happy choice. Whatever the new President may owe to study or experience in the arts of construction, his acknowledged genius (using the word in its strictest sense) stamps him as an Engineer, *nascitur non fit*. In something of his own vein of humor we may express the hope "that his shadow may never grow less."

CORRESPONDENCE.

Engineering Education.

An officer of a prominent railroad company who does not wish his name mentioned in this connection sends us the following "suggestions for editorial comment" on Mr. Waddell's paper. The writer has expressed his views on the subject so plainly that we print them as given; with the accompanying remark that as the discussion progresses he will doubtless find that others hold very similar views. This very criticism is what is desired, both by the writer and his publishers.

"I think the articles of Prof. Waddell ought to be criticised—in this way—No exception is taken to his proposed course of studies in the aggregate, except that no single individual can compass it all, either in theory or practice, within reasonable limits of time, and if he did get it, at least four-fifths of what knowledge he acquired would be of no practical value to him. He covers substantially the whole field of engineering and would fit students for a choice of any branch of it, expecting them to absorb the wisdom of a whole faculty of specialists and to be fully equipped at all points. I think that is impracticable. It covers too much ground. It appears to me that a school that recognized the *divisions* in the field of engineering, and arranged its course of studies with reference to each would come nearer realizing the ideal university for engineers. Let a course of studies be arranged for students who choose railroad engineering—another, and supplementary to that, for bridge engineering, and then for hydraulic, mining, electrical, mechanical, and the other branches of engineering, thus enabling students to acquire all that is necessary for the special branches, each may choose without wasting time on what they would never require. The field is too large for one to compass it all in school, and in practice an engineer must be a specialist.

"For the first year or two in such a school there are studies that apply to all the sub-divisions of the science of engineering. After that they should separate, and each follow its special line.

Meridian Lines in Daylight.

TARRYTOWN, N. Y., Jan. 25th, 1887.

EDITOR ENGINEERING NEWS:

Dear Sir:—Mr. N. Spofford in his article on the "Massachusetts and New Hampshire Boundary Line" asks if any one has fixed their meridian from an observation of Polaris in the day time. That method has been employed by the Canadian Government land surveyors in Manitoba and the other northwest territories for a number of years, it being a clause in the deputy land surveyors instructions to establish the meridian line in that way in some cases.

Yours truly, A. J. MCMILLAN.

A Manufacturers' Exhibition.

PAWTUCKET, R. I. January 25, 1887.

EDITOR ENGINEERING NEWS:

We are attempting in this city to erect a soldiers memorial building, and the ladies of this city have been much interested in the matter, and are to hold exhibitions of various kinds. One of these exhibitions will consist of exhibits from the different manufacturers of this city, and the towns adjoining—Central Falls and Valley Falls. This manufacturers' exhibit will be the largest of the kind ever attempted in this State. Upwards of eighty of these manufacturing establishments are within a radius of one mile of the center of the city. We think that there are not many cities in the country, that can give such an exhibition. It will open Monday, January 31st, and continue one week. If you, or any of the readers of ENGINEERING NEWS are within reasonable distance of Pawtucket, I think it would pay them to visit the exhibition. If they will make themselves known to me, I will take pains to make their visit as pleasant as possible.

Very truly yours,
HENRY F. JENKS.
Manager Manufacturers' Exhibition.

[We are very certain that an exhibition of so many different classes of manufactures as are promised in the above, from so interesting a locality as Pawtucket, and for so worthy a purpose, will prove very successful, and we hope to be able to chronicle such, in a future issue.—ED. ENG. NEWS.]

Contractor's Derrick.

To answer once for all several queries on that head we would say that for any further particulars relating to the "Contractor's Derrick," illustrated in last issue, all correspondents are referred to Mr. John Claffy, No. 48 Dey street, New York City, who is the sole manufacturer of the Kelly patent derrick furniture.

ED. ENG. NEWS.

Engineers' Club of St. Louis.

Meeting of January 19, 1887. A paper by H. S Pritchett on "Mexican Longitude Determinations," was read and by the aid of the magic lantern was fully illustrated. A complete description of the apparatus used, the method of making the observations and of computing the results were explained and the results were compared with those previously obtained by other methods. The professor showed a number of views of Mexican scenery and points of interest, with some remarks on peculiar features of the country and the characteristics of its people.

GAS-WORKS.—The Pine Bluff Gas Co., of Pine Bluff Ark., has purchased the plant of the Pine Bluff Electric Light Co., and will move it to the gas-works.

A company has been organized at Bristol, Tenn., to build gas-works.

Cast-iron and Wrought-Iron Columns in Fires.

AMONG the "Abstracts of the Institution of Civil Engineers" is one by Herr Bauschinger on the behavior of columns in fire, and under rapid cooling by water.

In 1884 new regulations were issued by the Berlin police authorities with regard to the use of cast-iron columns in new buildings, or alterations of old ones. According to these, "cast-iron columns which are not protected from the direct action of fire, may no longer be employed under the main walls of buildings of which the lower floors are used for business and storage purposes, and the upper floors as dwellings. In place of them will be allowed: —(*a*) Wrought-iron columns; (*b*) cast-iron columns, which are surrounded by an irremovable casing of wrought-iron, insulated by an air-space from the column; (*c*) columns of stone set in cement."

The severe character of these regulations induced the author, at the instigation or Mr. Kusterman (the owner of a large foundry in Munich), to undertake a series of experiments in order to ascertain the behavior of columns of various materials, but especially cast and wrought-iron, under the action of fire and rapid cooling by water. The regulations in question were the outcome of observations made after a large fire at a manufactory in Berlin, on the condition of the cast-iron columns used in its construction.

The author's experiments were made on columns of cast-iron, wrought-iron, and building materials of various kinds. The column to be tested was subjected in the Werder testing machine to the compressive load it would have to sustain in actual use, and in this condition heated to the desired temperature, and then suddenly cooled by jets of water.

For the purpose of heating, the column tested was partially surrounded by a perforated wrought-iron trough, in which wood was burned. Owing to the nature of the arrangements, cooling could only be effected from the upper side, the position of the column being horizontal; but this corresponds with what actually occurs at a fire in the majority of cases. An arrangement for measuring the deflections of the column during the experiments, in two directions at right angles to each other, was made by means of wires attached to the former, and acting on index fingers placed at convenient distance.

The temperature of the material tested was measured by means of alloys having various melting points, the highest being 600 degrees Centigrade.

Six cast-iron, three wrought-iron columns, and fifteen of various building materials were tested. The results showed that cast-iron columns best withstood the action of the fire and water, continuing to support their load even when red-hot and already cracked in places, whereas wrought-iron columns collapsed entirely under similar conditions.

The building materials tested were granite, marble, tufa, dolomitic limestone, concrete, paving stone, granitic marble, various kinds of sandstone, and ordinary bricks. Of all these materials the concrete proved to be the best, and after this ordinary brickwork. The concrete column tested remained uninjured after exposure to the treatment for one hour and three-quarters. None of the natural building stones resisted the fire; granite was relatively the best, then tufa.

New Canal.—The Chamber of Commerce, of St. Paul, Minn., will send memorials to the Wisconsin and Minnesota legislatures in favor of appropriations for the construction of a canal to connect Lake Superior and the Mississippi river.

The Proceedings of the German Cement-Maker's Association.

(Protokoll der Verhandlungen des Vereins deutscher Cement-Fabrikanten und der Section für Cement des deutschen Vereins für Fabrikation von Ziegeln, Thonwaaren, Kalk und Cement, Berlin, 1886.)

The meeting of this association, which represents an annual production of 910,000 tons of cement, was held at Berlin on the 26th and 27th of February, 1886. Several questions relating to the manufacture and testing of cement were discussed, and a revised set of standard rules adopted. Among other experiments reported to the association were a series of tests made with twelve different cements by three different persons. The cements were bought in the open market, and subjected to a variety of tests, including the tensile and crushing testsof different sand mixtures. A table was given containing the results obtained. The quickest cement set in three-quarters of an hour, and the slowest in thirteen hours. The coarsest sample left a residue of 49 per cent. upon a sieve of 32,256 meshes per square inch (5,000 meshes per square centimetre), while the finest left a residue of 20 per cent. upon the same sieve. The highest specific gravity noted was 3.137, the lowest 2.976. One of the cements was adulterated with slag, and was very deficient in strength. In the case of briquettes composed of neat cement and made by hand, the highest tensile strength was 702.6 lbs. per square inch (49.4 kilograms per square centimetre), and the lowest 323.6 lbs. per square inch (22.75 kilograms per square centimetre) in twenty-eight days. Tensile tests were made with briquettes composed of a mixture of one part of cement to three parts sand, some of the briquettes being made by hand and some by machine. In most cases the hand-made briquettes showed a slight increase of strength in twenty-eight days as compared with the machine-made. The highest tensile strength obtained with this mixture after twenty-eight days' immersion in water was 333.5 lbs. per square inch (23.45 kilograms per square centimetre), the lowest 94.75lbs. per square inch (6.66 kilograms per square centimetre). Crushing tests of the three to one mixture were also made; here the maximum was 3348.6 lbs. per square inch (235.43 kilograms per square centimetre), and the minimum 574.6 lbs. per square inch (40.4 kilograms per square centimetre).

In consequence of the results obtained, it was resolved to make the crushing test the decisive one. It was found that when the briquettes were exposed to the air for fourteen days, after having been immersed in water for a like period, the strength increased 50 per cent. as compared with briquettes which remained under water the whole of the twenty-eight days. The tests made with neat cement showed that the figures obtained did not allow a comparison to be drawn between different cements.

A discussion took place regarding the merits of various machines for the preparation of the briquettes. Two machines of different construction have hitherto been used; Dr. Böhme's, on the principle of a tilt-hammer, and Kæmp's, which resembles a pile driver in its action. It was remarked that Kæmp's machine gave irregular results according to the lubrication of the guide-rod. Böhme's apparatus was adopted as the one to be used for standard tests.

Of seventy-nine cements tested according to the standard rules at the Berlin testing station in 1883—4, sixty-seven had a tensile strength of more than 213 lbs. per square inch (15 kilograms per square centimetre), forty were above 284 lbs. per square inch (20 kilograms per square centimetre), and one above 427 lbs. per square inch (30 kilograms per square centimetre).—*Foreign Abstracts, Inst. C. E.*

WATER.

Dam.—A new stone dam will be constructed in the Milwaukee river at Milwaukee, Wis. About $30,000 will be expended, $50,000 of which is already provided.

JERSEY CITY, N. J.—The Board of Public Works has decided to contract with the company represented by John E. Bartlett for a supply of pure drinking water at a price not to exceed $38.50 per 1,000,000 gallons. According to the *World*, the Board of Aldermen, at their meeting on Tuesday, refused to concur in the action of the Board of Public Works, on the ground that the terms of the contract were exorbitant.

ARTESIAN WELL.—The largest artesian well in the world is being driven at St. Augustine, Fla.; it is 12 inches in diameter, 760 feet deep, and flows 7,000,000 gallons per day. It is being driven still deeper. For 550 feet the drill has been going through coral rock. The temperature of the water is about 80° F.

WATER METERS.—The City Engineer of Milwaukee, Wis., has requested the City Attorney to prepare a bill to be submitted to the Legislature compelling every consumer of water in the city to use a meter. The bill will be prepared at once and presented to the Legislature. The adoption of this measure, Mr. Benzenberg states, is the only effective way of reducing the consumption of water to a reasonable amount.

WATER COMPANIES.—Greenbush Water-Works Co, Greenbush, N. Y.; capital stock, $150,000; John Moffett, Henry C. Hodgkins, John V. Clark, R. Freeman, Frain Waltz, Francis S. Peck and Charles C. Moffet, of Watertown, N. Y.

Texarkana Water Co., Texarkana, Ark.; capital stock $100,000; J. A. Polhamius, C. L. Sampson and E. N. Maxwell.

Mystic Water-Works Co., Mystic, Conn.

THE INTER-STATE GAS CO., of St. Louis, Mo., was incorporated in September, 1855. During the past year it has built gas-works at Hutchinson, Kan., 20 years franchise; and Eureka Springs, Ark., 50 years franchise; also the water-works at Arkansas City, Kan., 20 years franchise.

ARTESIAN WELL IN AFRICA.—As part of the scheme of the late Col. Roudaire and M. de Lesseps to form an inland "African sea," it was suggested that an attempt be made to obtain water from artesian wells, with the idea of cultivating the surrounding country and using the rents for building the canal intended to connect the Mediterranean with the proposed sea. The first well was started in May, 1885; water was found at a depth of 295 feet, and in June, 1886, was running at the rate of 2,340 gallons per minute. As a consequence the banks of the Melah river (Tunis), which a very few months ago were deserts, are now populated and productive.

WATER SUPPLY OF SOUTH BEND, IND.—The city has now obtained an ample supply of good water from 15 artesian wells, averaging 120 feet in depth; the supply from the river will be abandoned. The first well was driven in 1878, and the superintendent of the water-works, E. L. Abbott, urged the driving of others, feeling confident that an ample supply could be obtained; he met with considerable opposition but has carried his point. Several wells were bored into the river-bed, and all are located in a small circle in and around the reservoir. Mr. Abbott says he has no doubt that many small cities could secure all the water needed in the same manner at a not excessive cost. Three turbine wheels and steam when necessary, furnish power for three pumps.

NEW WATER-WORKS.—Bridgeport, Pa. The council has authorized the borrowing of money for works, and the matter will be voted on by the people on February 15th.——Centerville, Ia. An artesian well is to be sunk.——Portland, Ore. A water supply will be obtained from Bull run, and the bad water from the Willamette river abandoned.——Hamilton, O. The city proposes to issue $15,000 for new boilers, repairs to the reservoir and other improvements on the water-works.——Memphis, Tenn. The legislative council has agreed upon a bill authorizing the taxing district of the city to issue bonds for not less than $1,500,000 for the construction of water-works; it is stated that the bill will pass the legislature without doubt.——Centralia, Ill. The water-works question is being agitated and will be decided upon shortly.——Birmingham, Ala. The Clayton Land Co. has closed a contract for a dam on Five Mile creek for the new water-works; it will cost about $100,000.——Key West, Fla. Water-works are to be built; address Messrs. Knight and Moreno.——Berthoud, Ca A system of water-works will be put in this spring at cost of $6,000.——Schwenksville, Pa. Albert Brower interested in the new water-works project.——Warsaw N. Y. The Eldridge Salt Co. is making surveys for a new system of water-works for the village.——Huntingburg, Ind. Water-works are to be established; John Ficken is interested.

NORWALK, CONN.—Francis Leonard, Superintendent of the Water-Works, writes us that no work of any importance will be done this year.

TELLURIDE, COL.—A serious fire caused a loss of about $50,000 on January 13th; the new court-house and nearly a block of buildings were destroyed. The Denver *Republican* states that the water-works were of no avail, as, owing to defective construction of the works, the supply reservoir was empty and there was no water for the hose. "Great indignation is expressed at the failure of the water-works, which if properly constructed would be perhaps superior to any in the State, and this serious disaster to Telluride would certainly have been avoided. The feeder to the reservoir is defective in not having been run high enough, and while there is an abundant supply at all seasons in the creek, the water is now too low to pass into the feeder."

DENVER, COL.—The Denver Water Company, in view of the rapidly increasing population and consequent increased demand for water, has purchased 53 acres of land for a reservoir on the Mauldin ranch, seven miles from the city. There is an abundant supply there from Cherry creek and from the hills; the water is of excellent quality. In September last Mr. C. P. Allen, chief engineer of the company, sunk a well on this land; the well was 17 feet deep and 14 feet in diameter, and the result of 25 days pumping was between 2,000,000 and 3,000,000 gallons per day. A reservoir will be constructed near the city, into which the pipes will discharge 9,500,000 gallons per day. The diameter of the pipes will vary from 36 to 24 inches, according to location. At the head of Deer street a capacious water tower will be erected. A line of pipe will extend along Deer street to Broadway, delivering an ample supply to residents in that vicinity. Above Broadway on Twenty-third street and along Grant avenue a 12-inch iron main extending a distance of several miles will be laid. This will insure a sufficient supply of water for all in that locality. The pressure will always be at a high point. In case of fire an automatic connection between the two water systems will greatly increase the pressure and prove of incalculable benefit. In making these changes the water company has gone to an expense of more than $200,000. It is expected that the new system will be in complete operation by the first of next year.

COLUMBUS, O.—The Water-Works Trustees have presented their report to the city council. The Board has visited Chicago, Milwaukee, Detroit, Cleveland, Buffalo, Toledo, Lockport, Niagara, Pittsburg, Cincinnati, Hamilton, Philadelphia, Chester, New York, Brooklyn, East New York and Troy, and has inspected the water supply systems; they recommend certain improvements and ask the council to provide means for carrying out these improvements. A new pumping engine of 15,000,000 gallons daily capacity is necessary, the estimated cost is $750,000; an additional water supply is also necessary, the approximate cost of which is estimated at $60,000; a new reservoir will be required in this connection. Pipes, 6, 8, 10 and 12-inch, to the amount of $48,483 have been ordered laid or petitioned for. During the past year property owners have advanced $9,237.79 for pipe laying, under agreement for the refunding of the money by the board. By carrying out the proposed plans the city would be divided into two fire districts, the pressures in which would be independent of each other. The following summary is submitted:

Money to be refunded for lines laid	$9,237.79
Fifteen million gallon pumping engine, complete	75,000.00
Water supply	60,000.00
Land and reservoir	35,000.00
Seven and one half million gallon pump complete	30,000.00
Buildings and foundations	15,000.00
Boilers and settings	5,000.00
Thirty-inch main from present works to high service station	108,032.0
Twenty-inch main from high service station to Rich street	34,523.00
Twelve-inch main in Wall from Spring to Livingston avenue	9,200.00
Pipe lines ordered laid and petitioned for	48,483.00
Distributing systems, valves, etc	5,000.00
Total	$434,525.79

The new works and pipe lines are very much needed and the Board urges the council to act promptly so as to get the matter before the Legislature as soon as possible.

CHICAGO SEWERAGE.—The engineers appointed at the instance of the City Council to devise a plan to dispose of the sewage of the city without contaminating the supply of drinking water from the lake, will recommend the extension of the Chicago river to the Desplaines river, which in turn empties into the Illinois and thence into the Mississippi river. The plan involves cutting a passage through a bed of rock for a considerable distance, but it is claimed that when the work is once accomplished it will give a fall of 35 feet and divert the water now flowing into Lake Michigan in the opposite direction. The cost of the proposed work is estimated approximately at $15,000,000.

WATER SUPPLY OF ST. LOUIS, MO.—The bill before the Municipal Assembly appropriates $45,000 for the construction of a new pumping engine, to be used at the low service station. The proposed addition to the capacity of the works is to accommodate the increased demands upon the water supply during the next three or four years, or until the new low-service station shall have been completed. If the bill passes a peculiar arrangement will be made for the pump. The construction of the extension of the low-service division having been delayed so long, it will be necessary to put in some temporary work at this station in order to keep up the supply of water during the next three or four years, while the permanent works are being built. Commissioner Whitman has had this matter under consideration for some time, and has devised a plan that will answer the purpose and at the same time not be too expensive. The great rise and fall of the river at the station (something over 40 feet) and the necessity of being able to command the water at all stages, makes the construction of even temporary works both difficult and costly. The design contemplates the erection of a wrought-iron caisson, just south of and adjoining the present engine pits, in which will be placed a floating boat or scow of wrought-iron, on which shall be placed the pumping engines.

LAND DRAINAGE IN MISSOURI.—The large drainage enterprise now being prosecuted in southeast Missouri was organized about one year ago as a private undertaking, the company controlling through purchase and by contract with New Madrid county, about 200,000 acres of land, being nearly all of the west half of the county. The work to be done consists in improving by deepening and straightening the channels of Castor and Little rivers, and cutting channels for the shallow sloughs, now the natural but insufficient drains of the wide, flat bottoms of these streams. The Little river valley begins in the southern part of Cape Girardeau county, and extends south into Arkansas. It is from twelve to twenty miles wide, and about eighty miles long, comprising more than 800,000 acres, nearly all of which is covered with a heavy growth of timber, and is now too wet for cultivation. It is flat and about level in its east and west cross-section, with a uniform slope to the south of a little more than one foot to the mile in its upper part, and a little less than a foot to the mile in the southern part. Its present wet and swampy condition is entirely due to the fact that the two streams which enter it have their sources in the hilly country to the north, and debouch rapidly flowing floods into their crooked, bayou-like channels in the valley, where the slope of their beds is not so great, and thus overflow the bottoms.

Before the settling up and improving of the country at the sources of these streams by clearing away the forests, this feature of floods did not exist, and it is only during the past seventy years that this swamp has been, and still is in process of development. These overflows have destroyed the timber in places, and caused a luxuriant growth of swamp vegetation to spring up, which again further impedes the flow of the water and increases the overflows. At such places the channels have become so clogged up that nearly all of the water flows out over the bottoms to be collected again into the channels miles below. This is the section of southeast Missouri which has been known as the "Sunk Lands," and had actually become to be considered as owing its overflows to a sinking of the land during the earthquake of 1811, until that false idea was confuted and dispelled by the information brought forth by the various surveys made by Otto Kochtitzky, C. E., of Sikeston, Mo., for railroad and other purposes about the year 1876.

The work now being done will give a capacity of channel equivalent to at least five times that of the present tortuous one, even where it is not clogged up, by the plan of cutting off the long bends and clearing out and deepening the old channel. The cut-offs are so located as to utilize as much as possible of the old channel and still maintain the general course of the river to the southward. The length of the new channel will be only little more than half that of the present one, and the velocity of the current will be increased from three-fifths of a mile per hour to a little over two miles per hour. The company is using a dipper dredge with a capacity of 80 to 100 cubic yards per hour. This machine takes out a sound, green oak stump 2 feet in diameter, without undue strain, and removes with perfect ease any fallen timber lodged in the old channel. The work has progressed only about three-fourths of a mile for the completed new channel, but is being pushed to the full capacity of this one dredge. The company contemplates putting in another dredge next spring. It is estimated that the work will cost but a little over $1 per acre on the land drained.—*Age of Steel.*

NEWS OF THE WEEK.

Railroads, Bridges and Canals.

Brooklyn Elevated R. R. Co.—At the recent annual meeting the following officers were re-elected: Henry W. Putnam, New York, President; Elbert Snedecker, Brooklyn, Vice President and General Manager; Stephen Pettus, New York, Secretary and Treasurer; J. W. W. Mitchell, New York, Assistant Secretary and Cashier; George B. Cornell, New York, Chief Engineer, and Walter B. Longyear, New York, Auditor.

Cost of Cable Railroads.—The following is a statement of the cost of the Eden Park Inclined Railroad, at Cincinnati, O.; the line is four miles long: Eight miles of track, including wheel vaults, $309,964; machinery, $27,764; engine-house, $22,432; equipment, cables and 20 cars, $15,217; car sheds and lot, $17,795; engine; $5,500; total, $428,672.

The Long Island Transatlantic Route.—Austin Corbin is reviving his project for a fast steamship line from Long Island to Milford Haven, in England. He has written Congressman Perry Belmont stating that Fort Pond harbor is one of the best on the coast and recommending that the government appropriate $250,000 for the construction of a breakwater. Mr. Belmont favors the project and will endeavor to include the appropriation in the new River and Harbor bill.

Alabama Asphalt, Mining & Land Co.—The company has been organized at Birmingham, Ala., to operate the asphalt deposits found in Morgan county. The material is reported to be of fine quality. President, Charles Handy, Atlanta, Ga.; Vice-President, Col. Talliaferro; Secretary, Charles M. Erwin; Manager, D. T. Marble. Capital stock, $300,000.

The Abt Rack Railroad System.—On January 5th a contract was signed abroad for the construction of a rack railroad on the Abt system from Puerto Cabello to Valencia, in Venezuela, South America. The length of rack-rail sections will be 2.42 miles (3.9 kilometres); the rack will consist of three parallel rack bars, and will be supplied from Germany. The locomotives, which will have three coupled driving pinions, are being manufactured in England. The system has been described in our columns.

St. Louis Bridge.—The Senate bill authorizing the construction of a bridge across the Mississippi river at St. Louis has been passed. It will be built between the Eads bridge and the mouth of the Missouri river. The bill provides that no bridge shall be erected in future within two miles above or below the proposed new structure. The Eads bridge was built at a cost of between $3,000,000 and $4,000,000. It is expected that the new bridge will be constructed without any further delay.

Bridge Estimates.—At Cincinnati, O., the following estimates have been submitted for bridges for the West Liberty Street Extension Association: (1) Bridge over the Cincinnati, Hamilton & Dayton R. R., excavations, 1,500 cubic feet at 30 cents, $450; stonework and masonry, 2,312 feet at $6, $13,872; iron bridge, 55 feet at $55, $3,080. Bridge over Mill creek, excavations, 6,000 cubic feet at 40 cents, $2,400; piers, 36,000 cubic feet at 50 cents, $18,000; filling, 400 cubic feet at $8, $3,200; lumber, 67,000 feet at 3 cents, $2,010; stonework and masonry, 6,420 cubic yards at $8, $51,360; iron bridge, 84 feet at $75, $6,300; total, $100,672.

Electric Motors in New York City.—The experiments being made with the Julien electric motor on the Eighth Avenue Surface Railroad, are reported to show favorable results. A trip was made on Saturday last from the stables at 49th street to 105th street, about five miles; the round trip, including switching, occupied 48 minutes, and the average speed maintained was six miles per hour. This is a storage battery system, as used in Paris, and the motor, which is smaller than an ordinary car, was brought from France. The batteries add about five tons to the weight of the car. W. P. Harvey, of Philadelphia, and Charles B. Murray, of Cincinnati, are interested.

Mississippi Levee Commission.—Under date of January 1st the Levee Commission makes a report covering receipts and expenditures from July 1st, 1886, to January 1st, 1887. The total receipts were $100,228.90, and the total disbursements $98,260.79; leaving a cash balance of $1,968.11. Chief Engineer Wm. Starling gave also a detailed account of work performed. In connection with the much discussed problem of increase in the general high water line by the closing of the innumerable present outlets, Mr. Starling thinks it is only the part of safety to assume that this line will rise and to strengthen and raise the levees accordingly. He cannot state the probable height, whether it will be 7 feet or more, as computed in 1858 by army engineers, or nearer the estimate of Mr. Eads, who claims the increased velocity will secure by scour the necessary waterway and make no elevation of levees necessary. Mr. Starling evidently believes in a middle course.

Lighthouse.—The tower of the lighthouse at Skilligalle, Mich., is reported to be badly cracked and will have to be taken down and a new one rebuilt. The estimated cost of rebuilding is $8,000.

New Railroads.—Ontario & Quebec R. R. The line is being surveyed in the neighborhood of Blue Bonnets, Ont., near which place it will connect with the Atlantic & North West R. R.——Norfolk & Western R. R. The chief engineer has been ordered to survey a line to connect with the Cincinnati, New Orleans & Texas R. R. (a leased line of the Cincinnati Southern R. R.). ——Denton & Northwestern R. R. The survey is being made for this Texas line.——St. Louis, Kansas City & Colorado R. R. The surveyors are now working near Warrensburg, Mo.——Chicago, Burlington & Northern R. R. The line will be extended this spring from Galena, Ill., to Shullsburg, Wis., where it will connect with the C. M. & St. P. R. R.——Omaha, Lincoln, Hartland & El Paso R. R. The line is to run from Omaha, Neb., to El Paso, Tex., 950 miles; the preliminary surveys will be started shortly. President, L. S. Jones, Hartland, Kan.— York Beach R. R. One mile of road bed is finished and the York river bridge commenced; J. P. Norton, York, Me., has the contract for Section No. 4——Chicago, Burlington & Quincy R. R. A line is projected from Chicago to Springfield, Mo., via Hannibal.——Cincinnati, Indianapolis, St. Louis & Chicago R. R. A line is being surveyed between Columbus, Ind., and Effingham, Ill.; from Switz City to Effingham the narrow gauge road will be acquired and widened to standard gauge. ——Chicago, Milwaukee & St. Paul R. R. On the line from Ottumwa, Ia., to Chillicothe, Mo., 130 miles, the grading has been completed and 40 miles of track laid; the line will be completed by April 1st.——Atchison, Topeka & Santa Fé R. R. Surveyors are at work near Pueblo, Col.——Cannelton, Tell City & Gentryville R. R. The survey has been completed and work will be commenced this spring at Gentryville, Ind.——Meriden & Cornwall R. R. The line will be extended to Waterbury, Conn.——The railroad now being constructed from Canastota to Camden, N. Y., will be extended to Carthage.——A line is being surveyed between Williamsport and Binghamton, N. Y.——A railroad is to be built from Gallup, N. M., to Cortez, on the Atlantic & Pacific R. R., 170 miles.

New Railroad Companies.—Topeka, Blue Valley & North western R. R. Co.: from Topeka Kan., to Clay Center, 500 miles; C. N. Beal, Jonathan Thomas, of Shawnee county, and others.——New York Harbor R.R. Co.: on Staten Island, 22 miles; capital stock, $500,000; Howard Carroll, Edward E. Gedney, James McNamee and others.——Chicago, Paducah & New Orleans R. R. Co.: capital stock, $10,000,000: President, W. G. Wilson, 175 Dearborn street, Chicago; the line will be surveyed in the spring.——Republican Valley & Wyoming R. R. Co., capital stock, $1,400,000; G. W. Holdrege, C. S. Dorman, P. S. Eustis, and others.——Springfield & Southern Illinois R. R. Co.; from Springfield, Ill., to Pinckneyville; capital stock, $1,500,000; T. B. Needles, Amos Watts, Amos Miller, and others.——Kansas Valley R. R. Co.; from Kansas City, Mo.; to Denver Col., 405 miles; office at Junction City, Kan.; capital stock, $10,000,000; Thomas A.Osborne, Topeka, Kan.—— Chicago, Lake Geneva & Pacific R. R. Co.; from Chicago to Portage, Wis., 110 miles; capital stock, $2,000,000.—— Cincinnati, Florence & Aberdeen R. R. Co.; from Tullahoma, Tenn., to Florence, Ala.; capital stock, $500,000. ——Wilmington Sea Coast R. R. Co.; eight miles; capital stock, $100,000; James Sprunt, W. Larkins, of Wilmington, N. C., and others.——Kansas Western R. R. Co.; includes lines in every county except Doniphan; work is to be commenced shortly; capital stock, $50,000,000; George J. Gould, New York City.——New York & Massachusetts R. R. Co.; a reorganization of the Poughkeepsie, Hartford & Boston R. R.; capital stock, $1,000,000; George P. Pelton, Jared Corlies, of Poughkeepsie, N. Y.——Louisiana, Arkansas & Missouri R. R. Co.; from Brinkley, Ark., to the Louisiana state line; capital stock, $2,600,000. A. W. Soper, New York City, President.——Lake Erie, Alliance & Southern R.R. Co.: the company will acquire and extend the Cleveland, Youngstown & Pittsburg R. R.; capital stock, $3,000,000; B. G. Richards, Henry G. Morse, and others.——Montgomery & Chattanooga Air Line R. R. Co.; capital stock, $1,000,000; Josiah Morris, E. B. Joseph, of Montgomery, Ala.——Orlando, Winter Park & Maitland R.R. and Canal Co.; capital stock, $100,000; John G. Sinclair, Orlando, Fla.——Nashville, Clifton & Clarkesville R. R. Co.; Nashville, Tenn.; W. W. Southgate, Stanley Bell, and others.——Kinderhook, Valatie & Nivervile R R.Co.; between the places named in New York, 4½ miles; capital stock, $50,000; C. D. Hains, Elmer T. Haines Andrew J. Haines, of New York City, and others.

Peruvian Railroads.—The Peruvian Government contemplates several extensions and improvements in the railroad system. The line built by Henry Meiggs to a distance of 30 miles from the Pacific coast will be extended to the silver mines of Cerro do Pasco, 150 miles from the coast and 1,200 feet above sea level. Contracts for locomotives and rolling stock, to the amount of about $2,000,000, will be awarded to Philadelphia manufacturers. The locomotives will be built by the Baldwin Locomotive Works, and will be of peculiar design, specially constructed for running on steep grades. In addition to the construction of the railroad it is proposed to drive a tunnel, tapping the silver mines 150 feet below the workings and thus effectually drain them. The work will be pushed forward rapidly by the English syndicate, represented by Grace Brothers, of New York City.

Te hnical Uniformity on European Railroads.—The Second International Conference for Technical Uniformity on Railroads was held at Berne in May, 1886, attended by delegates from Germany, Austria, Hungary, France, Italy and Switzerland. The following recommendations were adopted, subject to ratification by the several governments:—

The gauge for new lines and renewals to be 4 feet 8½ inches, except on curves where it shall not exceed 4 feet 9¼ inches. The axles of freight cars to be at least 8 feet 2½ inches between centers; width of tire from 5.91 to 5.12 inches; play of flanges, 1.38 to 0.60 inch; height of flange, 1.42 to 1 inch; minimum thickness of tire ¾-inch; and chilled cast-iron wheels are not to be run at speeds exceeding 28 miles per hour. The remaining recommendations relate to details of rolling-stock unknown in America.

Bridges.—At Minneapolis, Minn., resolutions have been passed authorizing the issue of 4 per cent. bonds for $180,000 for the steel arch bridge; $110,000 for the Franklin avenue bridge; and $100,000 for the 20th avenue bridge.——A bill has been introduced into the Senate to authorize an amendment to the bill for the Arthur Kill bridge; the change is to accord with the recommendations of the U. S. Engineers.——Preparations are being made to commence work on the A. T. & S.F.R.R. bridge over the Missouri river at Sibley, Mo; the bluffs are being graded for the approach.——Work has been somewhat delayed on the Poughkeepsie bridge by the very cold weather, the cement freezing as soon as mixed; work has been continued on timber and earth work.——At Leavenworth, Kan., the city council has decided to repair the present Missouri river bridge, and to build a new one.——At Middletown, N.Y., a company has been organized to build a toll drawbridge across the Shrewsbury river, from Locust point to Oceanic.——The Union R. R. bridge, near Toledo, O., over the Maumee river, has had 200 feet of its length washed away by the floods.

Chicago, Kansas & Nebraska R. R.—The following represents the amount of work done in about five months from July to December, 1886:

Clearing and grubbing stations	1,838
Excavation—Solid rock, cubic yards	50,625
Loose rock, cubic yards	78,885
Earth, cubic yards	6,652,554
Overhaul—Cubic yards	8,885,026
Distance, feet	100
Pile and trestle bridges—Oak, feet board measure	21,936
Pine, feet board measure	2,864,542
Piles driven, lineal feet	142,272
Cast-iron, pounds	77,836
Wrought-iron, pounds	150,387
Culverts—Oak, feet board measure	1,008
Pine, feet board measure	88,481
Cast-iron, pounds	824
Wrought-iron, pounds	3,345
Iron pipe for culverts—Tons 4,685 = 35,0 0 lin. ft.	
Distance hauled, miles	7
Masonry—First-class, cubic yards	7,620
Second class, cubic yards	151
Rubble in cement, cubic yards	6,738
Rubble dry, cubic yards	1,937
Rip-rap, cubic yards	4,514
Excavation—Solid rock, cubic yards	10
Loose rock, cubic yards	343
Earth, cubic yards	25,554
Foundations—Oak, feet board measure	89,400
Pine, feet board measure	260
Piles, lineal feet	14,860
Cast-iron, pounds	
Wrought-iron, pounds	2,402

Mr. Robert W. Day, Assistant Engineer, Atchison, Kan., who furnishes the estimate, states that it is doubtful if this showing has ever been exceeded.

Proposals Open.

Grading.—Forty miles of the Chicago, Santa Fé & California R. R., in Missouri; in sections of 1 to 5 or more miles. Miller, Loomis & Gill, S. Clinton street, Chicago, Ill.

Street Lighting.—For three or five years; 200 lights now in use, 75 gas and the rest gasoline. John M. Ogier, Chairman of Street Lighting Committee, Cambridge, O.

Round House.—Twelve stalls; at Louisville, Ky. M. J. Becker, Chief Engineer, Jeffersonville, Madison & Indianapolis R. R., Columbus, O. January 31.

Gas Pipe.—For city parks; 4,000 feet of 1¼-inch pipe. James Brown, Comptroller, Allegheny, Pa.

Sewer and Street Work.—Repairing and cleaning sewers; grading Green street. Department of Highways, Bridges and Street Cleaning, Philadelphia, Pa. January 31.

Pier.—At foot of W. 34th street, Department of Docks, New York City. February 2.

Fire Apparatus.—Fire engine, ladder truck, etc. Fire Commissioners, Cincinnati, O. February 3.

Street Work.—Grading and cobblestone paving. Department of City Works, Brooklyn, N. Y. February 4.

Bridge.—Stone bridge; plans and specifications at the Town Clerk's Office, Pembroke; and the office of the engineer, W. McLean Walband, St. James street, Montreal. A. Foster, Mayor, Pembroke, Ontario, Canada. February 5.

Court House.—For San Joaquin county. Architects, E. E. Myers & Son, Detroit, Mich. County Clerk, Stockton, Cal. February 9.

Instruments.—Surveying and drawing instruments. Capt. James B. Quinn, U. S. Engineer Office, Duluth, Minn. February 19.

Steel Forgings.—25 sets of steel forgings and 12 sets of additional gas-check forgings, of American manufacture, for 3.2-inch guns. Price per pound. Ordnance Office, War Department, Washington, D. C. February 19.

Electric Apparatus.—Complete electric plant for 1,750 incandescent lamps of 16 candle-power each. The Trustees of the Toledo Asylum for the Insane, St Clair Building, Toledo, O. February 26.

Contracting.

The Ohio Contracting Co. has been incorporated at Van Wert, O., with a capital stock of $100,000.

Lamp Posts—The only proposal for cast-iron lamp posts at Cleveland, O., was from the Lake Shore Foundry, at $7.50 each.

Brick Paving.—H. J. Watson, of Nashville, Tenn., is having great success with his creosoted brick pavements.

The Illinois & Southern Construction Co. has been incorporated at Chicago by W. G. Wilson, J. N. Reece and A. G. Murray; capital stock, $10,000.

The Iron Substructure Co. has considerable work in hand in Ohio and other states. They are constructing a pier for the North Nashville bridge, at Nashville Tenn.

The Standard Railroad Construction & Equipment Co. has been incorporated at Camden, N. J. Capital stock, $2,000,000, with privilege to increase to $5,000,000.

Bridge Contract.—The King Iron Bridge and Manufacturing Co., of Cleveland, O., has been awarded the contract for the construction of the Albany street bridge at Boston, Mass. Their bid was $11,338; the lowest bid was $11,300.

Freestone.—The following were the proposals for freestone for the new high service pumping station at Chestnut hill, Boston: Jeremiah Carew, $21,646; J. F Carew, $22 775; F. G. Coughlan & Co., $24,530; Norcross Bros., $26,831.

Ferryboat.—The Harlan & Hollingsworth Co., of Wilmington, Del., has been awarded the contract for building three steel ferryboats for the Staten Island Rapid Transit Railroad Co. They will cost $100,000 each.

New Croton Aqueduct.—The Aqueduct Commission has rejected all the bids for the construction of the gate house at 135th street; the reason is that the advertisements had not been printed a sufficient number of times in the papers. The work is being readvertised.

Filtering Plant.—The following proposals have been received for a filtering plant for Allegheny, Pa.: Crocker Filtering Co., $150,000: National Water Purifying Co., $240,000; Newark Filtering Co., $324,500. No award has yet been made, and the matter will be presented to the council at the next meeting.

Grading and Paving.—The Board of Public Improvements, St. Louis, Mo., has awarded contracts as follows for grading and alley paving (limestone on edge): Fruin-Bambrick Construction Co.: No. 1842, grading, 20 cents per cubic yard; paving, $13 per square; total, $1,132; No. 1843, 20 cents, $13, $592; No. 1844, 20 cents, $13, $1,036; No. 1848, 22 cents, $13, $956. St. Louis Quarry Co.: No. 1845, 28 cents, $16 50, $1,239; No. 1849, 28 cents, $16.50, $1,464; No. 1850, 28 cents, $16.50, $2,209.50; No. 1851, 28 cents, $16.50, $1,908; No. 1852, 28 cents, $16.50, $3,029.80. Stifel & Ruckert, No. 1846, 22 cents, $13.75, $1,155. H. Brockschmidt; No. 1847, 19 cents, $13, $587.80,

Electric Subways.—Mayor Gardner, City Engineer C. G. Force, Electrical Engineer H. H. Rebbeck, David Monson, of the Board of Improvements, Alderman Herman and others, of Cleveland, O., were in New York recently to examine the electric subways.

Steamer.—The following proposals have been received by the Lighthouse Board, Washington, D. C., for the construction of the twin-screw steamer "Zizania": H. A. Ramsey & Sons, Baltimore, Md., $66,900; John H. Dialogue, Camden, N. J., $72,600; Pusey & Jones, Wilmington, Del., $85,000. The contract was awarded to H. A. Ramsay & Sons.

Masonry.—The following proposals have been received for the completion of the court-house and public building at Tyler, Tex.; McCarthy & Corbett, $21,670 ($782 to be deducted if granite is not used for the steps); John Myers & Son, $24,302, ($1,000); Frank Baldwin, $25,256, ($1,500); Dumesnil & Brothers, $25,400, ($600), $25,500, ($600); Rice & Bassett, $25,485, ($500); James H. Coster, $26,949, ($300); John Moore, $28,535, ($1,250); Moore & Bradbury, $31,490, ($495). The contract was awarded to Messrs. McCarthy & Corbett.

River Improvement.—The contractor to whom was awarded Section No. 3 of the Don river improvement, at Toronto, Canada, has declined to proceed with the work unless Section No. 2 is also awarded to him. Under these circumstances the city has decided to do the work under the direction of the city engineer, and he has already put about 200 men at work on the excavation at the Gaul Hill. In spite of the severe winter nine brick sewers are in course of construction.

Street Cleaning.—At Philadelphia, Pa., the following proposals have been received for cleaning streets in the Second district: Thomas Riley, $69,997; E. J. McFadden, $70,098.50; Thomas Smith, $71,000; John Mooney, $73,000; James White, $79,950; P. J. McAnee, $82,000; Michael Samuels, $97,500; August Ruck, $99,000; J. M. P. McNichol, $100,000; H. P. Conwell, 109,500. As the amount of money at the command of the departments is but $60,000 no award was made.

Jails.—Proposals for repairing the jail at Waterloo, N. Y., have been received from Ryan & McDonald, and from firms at Olean and Poughkeepsie.

At Appleton, Wis., the $25,000 6 per cent. bonds for the construction of a jail for Outagamie county have been sold to N. W. Harris & Co., bankers, of Chicago.

The contract for steel and iron cells at the county jail at Mississippi City, Miss., has been awarded to F. B. Hull, of Jackson, Miss.

Sewers.—The following proposals have been received at Newark, N. J., for the construction of a pipe sewer; 300 feet of 18-inch, 750 feet of 15-inch, three basins and seven manholes: James Maguire, $1.25, $1.15, $115, $38; Keogh & Conway, $1.28, $1.11, $115, $29; Morris D. Macknet, $1.45, $1.15, $97, $35; Wm. J. Hughes, $1.45, $1.23, $100, $33; F. W. Sullivan, $1.75, $1.50, $110, $45. The pipe to be vitrified, salt-glazed pipe; the basin heads to be solid granite head and sill, built with Portland cement. Ernest Adam is city engineer.

At Minneapolis, Minn., the city engineer has been directed to advertise for proposals for 4,500,000 brick, and 18 395 feet of 12-inch and 15-inch cement pipe; all to be of local manufacture.

At Saint Paul, Minnesota, the following sewers have been ordered, on Edgerton street, $21,170; Jackson street, $1,165; Summit avenue, $31,315; Laurel avenue, $360; also on St. Albans street, Lincoln avenue and Grand avenue.

A sewerage system is to be put in at Winona, Minn., by Chester B. Davis, of Chicago; the estimated cost of pumping station and 12 miles of sewers is $100,000.

At Minneapolis, Minn., the city engineer has recommended the construction of egg-shaped sewers in future, instead of pipe, on account of greater facility for cleaning and repairing.

A sewerage system is to be put in at Aurora, Ill.

Bridges.—The Massillon Bridge Co., of Massillon, O., has under contract 13 spans of iron bridge for the C. I. & St. L. R. R., one span of 140 feet and one of 160 feet have been completed. Also a span of 140 feet for the C. W. & B. R. R., and two spans of highway bridge at Momence, Ill., to cost $10,000. The company has also been awarded the contract for two spans of highway bridge at Anderson, Ind., 140 feet each, 18 feet roadway; also for one span in Lake county, Ind.

The Mount Vernon Bridge Co., of Mount Vernon, O., has been awarded the contract for the iron bridge over the Cumberland river at Nashville, Tenn. There will be one span of 250 feet, one of 80 feet, and two of 200 feet.

The bids for the iron bridge over the tracks of the West Chester R. R., at 47th street, Philadelphia, Pa., were: J. H. Hathaway, $29,080; W. Achuff, $33,000.

Street Work.—At New Orleans, La., the following proposal has been received for brick sidewalks, J. J. Keegan, $1.60 per square yard: 70 cents per foot for gutter and curb; 70 cents per cubic yard for filling, 10 cents, B. M., for cross walks.

At San Francisco, Cal., the street contractors have been notified that the basalt blocks must be in exact accordance with the specifications; the contractors have other sizes on hand and had asked permission to use them.

At Lake, Ill., the contract for street improvement has been awarded to Thomas Byner at $3.95 per foot.

At St. Paul, Minn., the following improvements have been ordered: asphalt paving on Western avenue (32 feet wide), $12,117; opening a 16 feet alley, $3,200; grading Edgerton street, $20,315; grading Fairmount place, etc.

At Brooklyn, N. Y., it is proposed to pave Bushwick avenue from Myrtle avenue to the city line with Belgian blocks. The estimated cost is $80,000.

At St. Louis, Mo., contracts for street work have been awarded as follows: P. D. Sage & Son, $2,618.77; Ed. W. Wittler, $376; Thomas Whelan, $831.60; John Donovan, $540; Fruin-Bambrick Construction Co., $3,716; St. Louis Quarry Co., $16,836.60; Stiffell & Ruckert, $1,155; H. Brockschmidt, $24,865.80; J. G. Perkinson, $6,467.40; Timothy Cavanagh, $10,180.50.

Masonry.—The following proposals have been received by Lieut. Col. Peter C. Hains, U. S. Engineer Office, Washington, D. C., for the construction of the reservoir outlet and wing walls in connection with the reclamation of the Potomac flats: Francis H. Smith, New York City, $91,177.05; Ross & Sanford, Jersey City, N. J., $91,608.52; Flannery Brothers, Washington, $98,931.50; J. B. Holliday, W. B. Wilson and George Cumberland, Washington, $109,812.40; Samuel Jacobs and Robert Strong, Washington, $113,777.62; John Moore, Syracuse, N. Y., $118,917.50; Boynton Brothers, Boston, Mass., $120,740; John E. Lyons, Baltimore, Md., $139,396.90; G. Peterson, Washington, $145,095.50; Beckwith & Quackenbush, Washington, $153,798.50. The structure will be of granite masonry on a foundation of piles, grillage and concrete, and will be built within a cofferdam in about 6 feet of water.

Street Improvement.—The following proposals have been received at Cincinnati, O., for improving Clifton avenue; the bids were from Hayes & O'Brien; C. W. Danenhower; M. Scully; Folz, Ashman & Co., and F. Kirchner: Broken stone (10,508 cubic yards), $1.90, $1.19, $1.60, $1.50, $1.75; crushed boulders (3,002 cubic yards), $3.50, $3, $2.50, $4, $3; crossings, (1,885 lineal feet), 75, 60, 68, 68, 65 cents; curbs, (10,900 lineal feet), 75, 59, 70, 68, 90 cents; 15-inch drain pipe (260 feet), $1.25, $1, $1.50, $1.40, $1.50; 12-inch drain pipe (300 feet) $1, 90 cents, $1.25, $1, $1.25; flags and gutters (4,750 feet), $1, 75 cents, 82 cents, $1.30, 95 cents; flag gutters (6,270 feet) 75, 60, 58, 68, 70 cents; grading (174,900 cubic yards), 26½, 24, 28½, 40, 29 cents; rubble masonry (140 cubic yards), $4.50, $5, $6, $5, $4; rolling (81,066 square yards), 5 cents in all bids; gravel (2,250 cubic yards), $2.75, $1.50, $1.90, $2, $2; well hole plates (6 pieces), $15, $21, $30, $25, $20. Totals, $107,372.75, $87,0097.32, $100,001, $126,845.70, $107,961.05. The contract was awarded to C. W. Danenhower.

Water Pipe.—At Minneapolis, Minn., the contract for 7,000 tons of water pipe has been awarded to Dennis Long & Co., of Louisville, Ky., at $34.50 per ton; the contract for hydrants was awarded to R. D. Wood & Co., of Philadelphia, Pa., at $36.50 each, and for special castings to the North Star Iron Works at 3¼ cents per pound.

At Philadelphia, Pa., the Water Department has awarded the contract for pipe to the Mellert Foundry & Machine Co.; 6-inch, 1.45 cents per pound; 10-inch, 1.43 cents; 16-inch, 1.42 cents; 20-inch, 1.41 cents; specials, 2.45 cents; large specials, 2,33 cents. The Camden Iron Co. received the contract for breeches pipe at 3.9 cents; and F. and J. Charner for brass at 10¾ cents for yellow, and 13 cents for red.

The Syracuse Water Co., Syracuse, N. Y., has sent to iron mills and pipe manufacturers in all parts of the country blank proposals for 348,000 pounds of 4-inch, 4,000,000 pounds of 6-inch; 8, 10 and 16-inch as required, 2,000,000 pounds of 12-inch, 17,000,000 pounds of 36-inch, or 21,000,000 pounds of 42-inch. The pipe is to be delivered by May 1st.

At Lake, Ill., the contract for water service pipe has been awarded to Thomas Byner at 60 cents per foot.

Bridge Substructure.—The following proposals have been received at Minneapolis, Minn., for the substructure of the 20th avenue bridge over the Mississippi river: Arthur McMullen, Mankato stone, $10.50 per cubic yard; granite, $28.50; lumber, $22; piling, 27 cents; excavation, 50 cents; rip-rap, $2. Ring & Tobin, Mankato stone, $11.85; Kettle river stone, $10.85; granite, $29; lumber, $23; piling, 20 and 33 cents; excavation, $1.50; rip rap, $1.75. Minnesota Stone Co., $12.15, no bid, $29 05, $22,50, 25 and 30 cents, 75 cents, $3.25. Thomas Daly, $12.90, no bid, $25, $22, 38 cents, $1.25, $2 25. The contract was awarded to A. McMullen. The city engineer has been directed to advertise for proposals for the superstructure of this bridge, and for the substructure of the Franklin avenue bridge over the Mississippi river.

The Union Bridge Co., of New York, is reported to have at last obtained a controlling interest in the Elmira mills. They will put in a steel plant for bridge work, rails, etc.; the transaction includes an interest in valuable ore mines, railway tracks, etc. The announced intention is to enlarge the Elmira works, and remove to that point the Athens Bridge Works now owned by the Union Company.

Water Works.—The following proposals have been received for the construction of the water-works at Wauwatosa, Wis.; the advertisement called for three classes of bids, to enable the work to be divided among several contractors, as the plant will consist of extensive machinery, buildings and pipe: For the work complete, W. Forrestal, $27,435; W. T. Casgrain, $27,950. For the pump well and distribution pipe, W. T. Casgrain, $6,200; J. Werner, $7,293 James Hoye, $7,337, J. C. F. Brand, $7,400. For the engine house and machinery, W. T. Casgrain, $15,175; G. M. Conway, $16,500. No bids for water pipe were received in consequence of an advance in the price. This, together with the advance in the price of labor will make it impossible to construct the works within the estimated amount, $24,500. The probable advance in cost is estimated at $3,000.

Dredging.—The following proposals were opened January 22nd by Gen. Wm. F. Smith, U. S. Engineer Office, Wilmington, Del.: In New Castle harbor, Del.; National Dredging Co.: Wilmington, Del., 12 cents per cubic yard, measured in the scow; Atlas Dredging Co., Wilmington, Del., 12.3 cents; American Dredging Co., Philadelphia, Pa., 13.5 cents; Frank C. Somers, Philadelphia, Pa., 14 cents; Baltimore Dredging Co., Baltimore, Md., 16.25 cents; Frank Pidgeon Dredging Co., New York City, 33 cents (provided the dredging at Wilmington is also awarded).—In Wilmington harbor, Del., National Dredging Co., Wilmington, Del., 12 cents; Atlas Dredging Co., Wilmington, Del., 12.3 cents; Frank C. Somers, Philadelphia, Pa., 12.75 cents; American Dredging Co., Philadelphia, Pa., 14 cents; Baltimore Dredging Co., Baltimore, Md., 16 cents; George C. Fobes & Co., Baltimore, Md., 16.5 cents; Thomas P. Morgan, Washington, D. C., 17 cents; Frank Pidgeon Dredging Co., New York City, 27 cents.

Suit over a Caved-in Tunnel.—Jeremiah R. Byron, contractor for the tunnel in 42nd street, New York City, between First and Second avenues, recently brought suit for damages for loss of his contract, which he declared the Commissioner of Public Works unjustly cancelled. The evidence showed that about 52 ft. of the brick arch fell on June 29, 1878, and that another large section caved in on October 20, same year. After the first mishap the Commissioner executed with the contractor a new contract based on improved specifications. The plaintiff then resumed work, but not getting on as fast as demanded, he was ordered to hurry up under penalty of another cancel. Failing to do so, as alleged, the second contract was annulled on November 2, 1878. In his complaint the plaintiff alleged that the absence of grading on Second avenue and the obstruction from debris prevented him from hurrying the work, and if there was fault anywhere it was not his. He charged the whole blame on the Department of Public Works. Assistant Corporation Counsel Scott, who appeared for the city, alleged inferiority of material and poor work. Among the witnesses called for the plaintiff was Mr. Collingwood, an expert civil engineer, and for the defendants Colonel Adams, Allan Campbell and John C. Campbell, also experts. The jury returned a verdict for plaintiff of $17,399.05.

Railroad Contracts.—Chief Engineer A. A. Robinson, of the Atchison, Topeka & Santa Fè R. R., has awarded contracts as follows for the construction of the new line to Chicago, to be known as the Chicago, Santa Fè & California R. R.: McArthur Bros., St. Paul, Minn., 60 miles, west from Fort Madison, Ia., (their headquarters will be at Keokuk, Ia.); Miller, Loomis & Gill, Chicago, Ill., 40 miles (this includes some very heavy work in Knox, Macon and Adair counties, Mo.; 10 per cent is rock excavation, and there are ten bridges, with a mile and a half of trestle and six truss spans); Williams, McRitchie & Co., Chicago; 40 miles; J. P. Price & Co., Topeka, Kan., 20 miles; J. H. Hampson, Leavenworth, Kan., about 60 miles, to the Mississippi river. The contracts for work east of the Mississippi have not been let.

McKenzie, Purcell & Co. are the contractors for Section 13 of the Algoma & Sault Ste. Marie branch of the Canadian Pacific R. R., 500 men have been already engaged: Carry & Dunn have the contract for clearing the right of way and building the trestles; Corbet & Kemp have a contract for one section.

A. J. Jolly & Sons, Pittsburg, Pa., have the contract for the construction of the extension of the Ohio River R. R. from Point Pleasant to Huntingdon, W. Va.; the contract includes 40 miles of road and the large bridge over the Big Kanawha river.

Miller, Loomis & Gill, Chicago, Ill., have the contract for 50 miles of the extension of the St. Joseph & Grand Island R. R., in Nebraska.